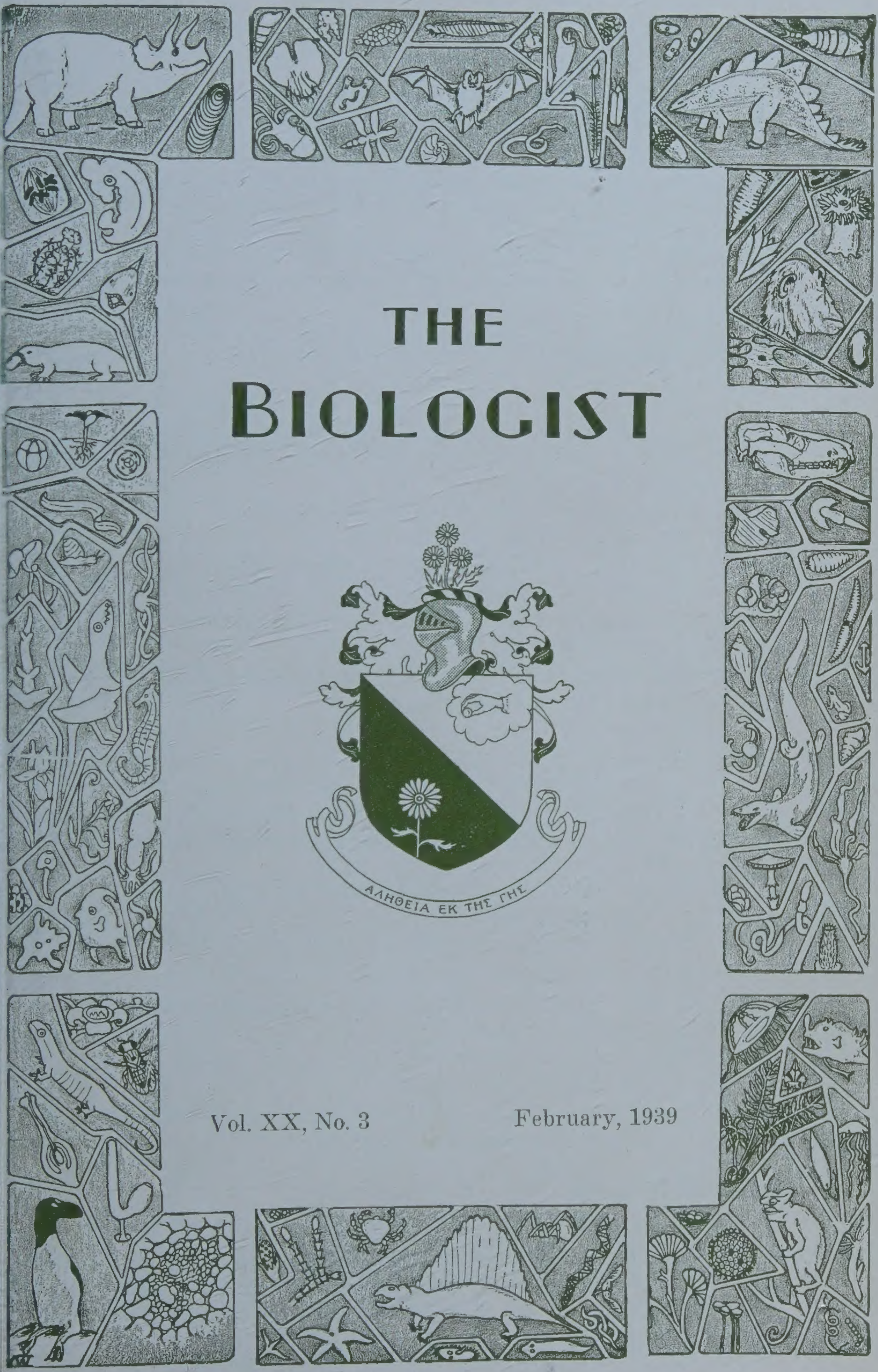
UNIVERSITY OF WASHINGTON



THE BIOLOGIST

ΑΛΗΘΕΙΑ ΕΚ ΤΗΣ ΓΗΣ

Vol. XX, No. 3 February, 1939

SCHWITALLA: THEODOR SCHWANN

PHI SIGMA
BIOLOGICAL HONOR SOCIETY

"The object of Phi Sigma is to promote interest in biological research. Although originally designated as an honorary biological research society, it should now be considered as a working guild of biologists interested in research. In effect, election to Phi Sigma should be an opportunity for better work, rather than merely election to an honorary society."

Mile Posts:

1915 March 17, Alpha Chapter organized, Ohio State University.

1916 May, Central Governing Body organized, BIOLOGIST first issued.

1917 June, last War-time BIOLOGIST issued.

1921 February, BIOLOGIST revived.

1924 December, First National Convention, Constitution revised, Washington, D. C.

1925 December, Second National Convention, First Scientific Program, Kansas City.

1926 December, Third National Convention, Second Science Program, Philadelphia.

1927 December, Third Science Program, Nashville.

1928 December, Fourth National Convention, Coat-of-Arms adopted, Fourth Science Program, New York.

1930 January, Council Meeting, Ritual Revised, Norman, Okla.
December, Fifth National Convention, Fifth Science Program, Cleveland.

1931 Phi Sigma Letters Registered, U. S. Patent Office.

1932 December, Sixth Science Program, Atlantic City.

1933 June, Sixth National Convention, Seventh Science Program, Chicago.

1935 December, Seventh National Convention, Eighth Science Program, St. Louis.

1937 December, Eighth National Convention, Ninth Science Program, Indianapolis.

Expansion:

The Constitution provides that: "An active chapter may be established in any institution of learning which requires for graduation the equivalent of four years of collegiate work, and which is equipped with facilities for research work. - - - - Any petitioning group must be active for at least one year before it may be granted a charter."

THE BIOLOGIST

Vol. XX Denver, Colo., February, 1939 No. 3

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DIRECTORY

OF ALL ACTIVE AND INACTIVE CHAPTERS

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ALPHA

Ohio State University, Columbus, Ohio, founded March 17, 1915, (Inactive).

BETA

University of Michigan, Ann Arbor, Michigan, founded June 3, 1916.

DELTA

University of Maine, Orono, Maine, founded January 27, 1917.

EPSILON

University of Denver, Denver, Colorado, founded March 5, 1917.

ZETA

University of Wisconsin, Madison, Wisconsin, founded May 30, 1917.

ETA

University of Akron, Akron, Ohio, founded April 20, 1921.

THETA

Michigan State College, East Lansing, Michigan, founded April 9, 1921.

IOTA

Washington University, St. Louis, Missouri, founded May 28, 1921.

KAPPA

University of Kansas, Lawrence, Kansas, founded May 31, 1921.

LAMBDA

University of Montana, Missoula, Montana, founded May 4, 1921.

MU

University of California, Berkeley, California, founded April 27, 1922.

NU

Washington and Jefferson College, Washington, Pennsylvania, founded May 11, 1922.

XI

University of Nebraska, Lincoln, Nebraska, founded May 3, 1934.

OMICRON

University of North Dakota, Grand Forks, North Dakota,
founded May 26, 1924, (Inactive).

PI

Emory University, Georgia, founded January 3, 1925.

RHO

University of Illinois, Urbana, Illinois, founded March 28, 1925.

SIGMA

University of Florida, Gainesville, Florida, founded December 4, 1925.

TAU

Duke University, Durham, North Carolina, founded March 4, 1926.

UPSILON

Miami University, Oxford, Ohio, founded May 7, 1926.

PHI

University of New Hampshire, Durham, New Hampshire, founded May 21, 1926.

CHI

Montana State College, Bozeman, Montana, founded February 11, 1927.

PSI

University of Washington, Seattle, Washington, founded April 7, 1928.

OMEGA

University of Oklahoma, Norman, Oklahoma, founded March 24, 1928.

ALPHA ALPHA

University of Southern California, Los Angeles, California, founded May 17, 1930.

ALPHA BETA

Mount Union College, Alliance, Ohio, founded May 17, 1928.

ALPHA GAMMA

University of South Dakota, Vermillion, South Dakota, founded May 15, 1928, (Inactive)

ALPHA DELTA

Lawrence College, Appleton, Wisconsin, founded March 7, 1929.

ALPHA EPSILON

University of Pittsburgh, Pittsburgh, Pennsylvania, founded March 23, 1929.

ALPHA ZETA

College of William and Mary, Williamsburg, Virginia, founded April 19, 1930.

ALPHA ETA

Oklahoma Agricultural and Mechanical College, Stillwater, Oklahoma, founded March 13, 1930.

ALPHA THETA

State College of Washington, Pullman, Washington, founded May, 1930.

ALPHA IOTA

Bucknell University, Lewisburg, Pennsylvania, founded January 9, 1932.

ALPHA KAPPA

Hunter College, New York City, founded January 8, 1932.

ALPHA LAMBDA

University of Utah, Salt Lake City, Utah, founded February 13, 1932.

ALPHA MU

University and State Agricultural College of Oregon, Eugene-Corvallis, Oregon, founded November 18, 1933.

ALPHA NU

University of New Mexico, Albuquerque, New Mexico, founded April 21, 1935

ALPHA XI

Rhode Island State College, Kingston, Rhode Island, founded May 17, 1935.

ALPHA OMICRON

Marquette University, Milwaukee, Wisconsin, founded June 18, 1938

Mt. Rainier from the Southwest Corner of the Henry Suzzallo Library

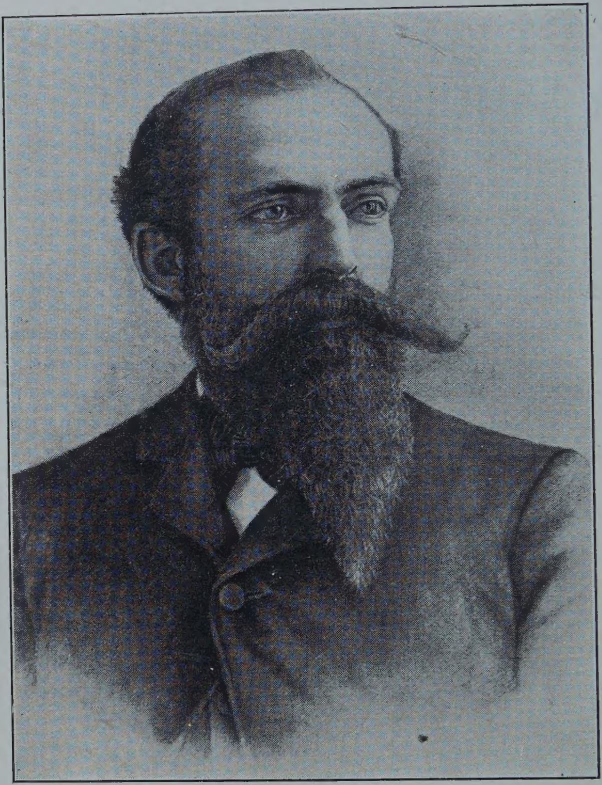
A portion of the biological work at the University of Washington is concerned with the fauna and flora of the

BIOLOGY AT THE UNIVERSITY OF WASHINGTON

I. PIONEER PERIODS 1879-1901.—THE YOUNG NATURALISTS SOCIETY

THE University of Washington was founded in 1861. While elementary instruction in biology and physiology appears to have been offered from its earliest years, the real origin of biological work at the University dates from the organization, on December 20, 1879, of a group of young men of 18 or 20 years of age, who styled themselves the Young Naturalists Society. Not at first connected with the University, the Young Naturalists maintained a club room and museum in a small building back of the residence of A. A. Denny, father of one of the charter members. Their early meetings were amateurish in the extreme. Essays were read by the members on different natural history subjects. Conchology, ichthyology, ornithology, paleontology, mineralogy, geology, entomology, botany, ethnology—the nine sections into which the society of about 25 members organized itself in 1883—demonstrate at least a catholicity of interest! And the debate: "Resolved that the Colorado potato bug is an injury to mankind," which was won by the negative, shows that the social implications of biology were not being neglected. Frank P. Gilman (1853-1918), professor of natural science at the University from 1880 to 1882 and after 1886 a Presbyterian missionary in Hainan, China, lectured before the society on coal. But Seattle in 1880 was still a small pioneer community, three years away from a railroad, with only 3500 inhabitants, with the University a tiny institution enrolling less than 50 students.

In 1882 Orson Bennett Johnson (1848-1917), a draughtsman and amateur naturalist of Salem, Oregon, was appointed professor of natural science at the University. Johnson was born at Williston, Vermont, of colonial stock. He had seen active service in the last year of the Civil War; had obtained a B.L. from Union College Law School at Albany, N.Y. in 1869, and had come west to Portland in the same year, at which place and at Salem he had since been employed as surveyor and draughtsman. In Oregon he had been associated with Thomas Condon (1822-1907), geologist and president of the University of Oregon, and had helped the paleontologists, Marsh and Cope, with the preparation of some of their material.



Prof. Orson Bennett Johnson (1882-1917)

From 1882 to 1896 Professor of Natural Science at the University of Washington

From 1882 to 1892 Professor Johnson held the chair of natural history at the University of Washington. He immediately associated himself actively with the Young Naturalists, who in 1886 erected a $2000 club house on the University campus on what is now the site of the Cobb Building in down town Seattle, and under whose auspices the natural history collections of the University were maintained. Johnson's own interests were diverse, as befitted one in his position. Beyond one or two lists of birds, he did not publish, but he was in active correspondence with eastern specialists. Peckham named an Attus spider after him in 1883 and Ulke a beetle, a Pterostichus, in 1889, and he was furnishing material to such other specialists as Jordan in fishes, Miss Rathbun in crustaceans, Dall in mollusks, and Strecker in butterflies and moths. Chief among his students may be mentioned Charles Vancouver Piper (1867-1926), first professor of natural history (1892-1903) at Washington State College, and then agrostologist with the United States Department of Agriculture. Piper laid the foundations for the University Herbarium, now housed in the Department of Botany.

In the mid-nineties the Young Naturalists Society experienced the most active phase of its existence. Professor Johnson was being forced out of the picture by the onset of a very crippling form of arthritis, that during most of the last twenty years of his life confined him to a wheel chair,* but he still attended many of the meetings. Charles Hill (1862-1937; M.S., Michigan, 1892; Ph.D., Northwestern, 1899; M.D., 1902) succeeded (1892-1898) Johnson. Trevor Kincaid (M.S., 1901), later head of the Department of Zoology, Henry W. Hindshaw, from 1894 to 1898 curator of the University Museum, and Adella M. Parker, one of Professor Johnson's students, injected new life into the group.

In July of 1894, 1895, and 1896 the Young Naturalists conducted dredging expeditions on Puget Sound. In the latter two years they were accompanied by E. E. Starks of Stanford University, who made collections of fishes that were published later on. The other groups collected were sent to various specialists in the east: the hydroids to Charles C. Nutting, the Bryozoa to Alice Robertson, the echinoderms to Hubert Lyman Clark, the Mollusca to William H. Dall, and the Crustacea to Mary J. Rathbun. Under Brooks Randolph, a charter member of the society, the conchological collection, now in the University Museum, was greatly improved, so that in 1897 it contained 7500 mounted specimens representing 384 genera and about 1300 species. The library of the society had increased to several hundred volumes and a dozen or so scientific journals were being received.

After 1898, the Young Naturalists languished. The removal of the University to the present uptown campus in 1895 had divorced the club house from the rest of the institution, and the decision of the Regents about 1906 to lease the down town tract for business purposes made it necessary for the society to move or disband. They chose the latter alternative, and their library and collections were transferred to the University.

In 1900 Seattle passed the 80,000 mark in population, and the previous year the University had enrolled more than 500 students, so that both community and institution were growing up. With Hill's resignation in 1898, the headship of Biology had fallen to Homer Redfield Foster, a botanist with an M.S. (1898) from Michigan. At the same time, Trevor Kincaid, still an undergraduate, had been given charge of the work in zoology, and was made an assistant professor in 1899 when he received his B.S. In 1901 the Department of Biology was divided into the Departments of Botany and Zoology and the pioneer period in the development of biology at the University may be said to have come to a close.

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* It was during this period that Johnson arranged most of the insect collection that he donated to the University in 1916, the year before he died. The collection was constituted about as follows: Coleoptera 4500 species, Lepidoptera 2000 species, other orders about 1000 species.

II. Present Organization of Biological Science at the University

The Departments of Zoology and Botany created in 1901 represent the central core of biological work at the University. Closely related to both is the Museum, which was recognized as part of the University as early as 1894 but has had a Director continuously in charge only since

Airplane View of the University of Washington Campus

All the principal buildings are shown except the Oceanographic Building which is to the left

1909, and the Puget Sound Biological Station at Friday Harbor, which was organized in 1904 and after 1930 was merged with the Oceanographic Laboratories. Related more especially to Zoology is the work in Paleontology offered by the Department of Geology since 1907, the Department of Anatomy which split off from Zoology in 1917, and the work in Fisheries which separated from Zoology in 1919. Related to Botany is the Department of Bacteriology which split off from it in 1915, the College of Forestry, which was organized in 1907, and the Arboretum organized in 1934. The College of Pharmacy goes back as far as 1894, but a full time instruction was not assigned to the work until 1903. Work in Biological Chemistry has been offered by the Department of Chemistry since 1907 and work in Nutrition by the School of Home Economics since 1924. Finally, the Oceanographic Laboratories, organized in 1930 and composed of members of the Departments of Physics, Chemistry, Bacteriology, Botany, Zoology, and Geography, attempt to apply the results of work in diverse fields to the study of the ocean.

Despite the three quarters of a century that have elapsed since its foundation, the University of Washington as an institution with any pretentions is relatively young. It passed the 2000 level in its registration only in 1909, the 5000 level in 1917, the 10,000 level in 1935. The Graduate School was founded in 1911 and for a long time scarcely any of the students in science went beyond the master's degree. Of the sixty or seventy doctor's degrees in biological science that have been granted, nearly all have been awarded since 1930.

Societies. The Washington Chapter of the Society of the Sigma Xi was installed April 24, 1907. At present it holds six or seven meetings a year and exercises a stimulating influence on the research of both faculty and students. The Psi Chapter of the Phi Sigma Society was installed at the University on April 7, 1928. It meets about nine times a year and serves to foster research in biology especially among the students. Some of the women on the Campus with a doctor's degree or its equivalent and active in the continuance of their research formed a research group in 1928 or 1929. At the present time there are about ten members who meet for dinner once a month; at each meeting one member presents a paper on her current research. The acme of campus research organizations is represented by the Research Society of the faculty, which was organized in October 1919. Men are admitted to associate membership who have published research papers over a period of five years, to full membership after they have been publishing for a period of ten years. Meetings are held every Thursday morning throughout the school year at eleven o'clock, at which time one member reports on the research he has accomplished since his previous report. The present membership is about 90, about two-thirds of them being full members.

Physical Plant. The Departments of Geology, Zoology, Botany, and Bacteriology were housed in what was known as the Science Building (rechristened Vernon Lewis Parrington Hall in 1931) from 1902 to 1930; since then they have occupied the Orson Bennett Johnson Biological Laboratory, named in honor of Professor O. B. Johnson. The Physiology Division of the Department of Zoology is quartered in the old chemistry building, rechristened Physiology Hall in 1937. The College of Forestry has occupied the Forest Products Laboratory (since 1921) and the Alfred H. Anderson Hall (since 1926) and the Museum since 1927 has been in the Washington State Museum Building, formerly occupied by the Library. The work in Chemistry and Pharmacy is given in the new Daniel Bagley Hall completed in 1937, that in Home Economics in the building of the same name. The work in Oceanography is housed in the Oceanography Building completed on the Seattle Campus in 1932 and in the group of buildings formerly occupied by the Puget Sound Biological Station at Friday Harbor. Anatomy and Fisheries still occupy temporary structures.

Publications. The University has sponsored various series of publications which publish the results of biological research.

Publications of the Puget Sound Marine (after Vol. I, Biological) Station under the editorship of T. C. Frye. Vol. I-VII, 1915-1931; discontinued.

University of Washington Publications in Geology. Vol. I, 1916- IV, 1937.
University of Washington Publications in Fisheries. Vol. I, 1925- II, 1929; discontinued.

Memoirs of the University of Washington. Vol. I, 1931.
University of Washington Publications in Biology. Vol. I, 1932- IX, 1938.
University of Washington Publications in Oceanography. Vol. I, 1932- III, 1938.

University of Washington Thesis Series. Vol. I, 1931- III, 1938.

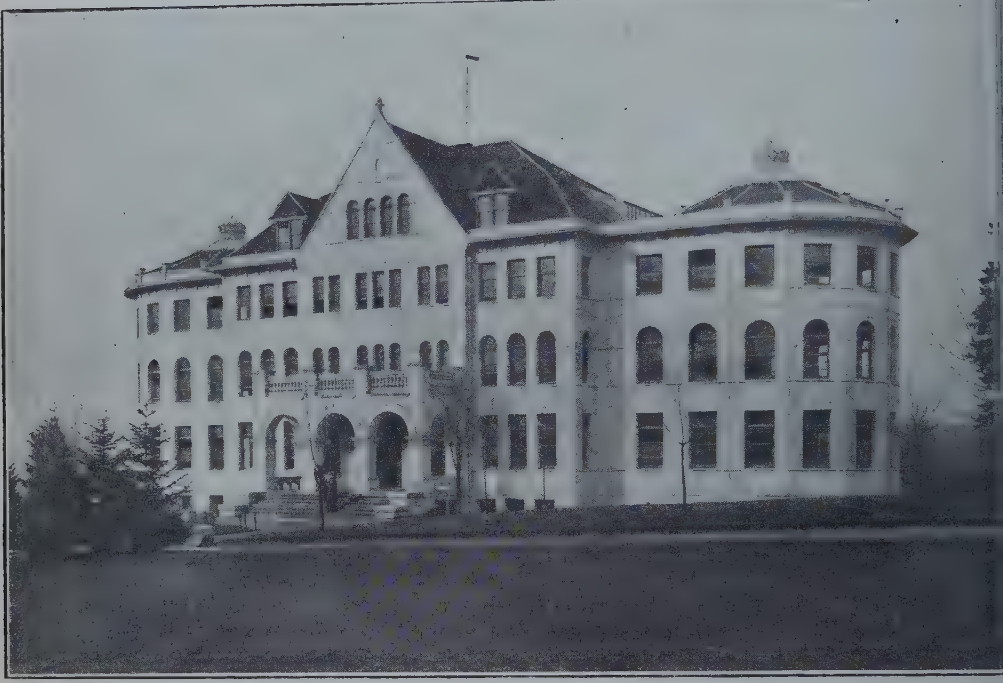
III. Zoology

The Department of Zoology at the University of Washington is to a very great extent the personal achievement of its first and present head, Trevor Kincaid (M.S., 1901). Kincaid was born in Peterboro, Ontario in 1872, the son of a physician. From his earliest years he was interested in natural history, and upon his removal with his parents to Olympia in Washington in his seventeenth year he began to study the local fauna. Within five years he had a collection of nearly 60,000 specimens of insects and had sent nearly 100,000 specimens to eastern specialists. Over fifty new species of spiders were detected in this material by Banks, 27 new species of saw flies were described by MacGillivray, four or five thousand bees were sent to Cockerell, and several thousand miscellaneous insects to Liebeck.

Prof. Trevor Kincaid
Head of the Department of Zoology

Immediately upon his entrance to the University in 1894, Kincaid joined in on the work of the Young Naturalists Society with enthusiasm. In the summer of 1897, at Jordan's invitation, he accompanied the Alaska Fur Seal Commission to the Pribilof Islands, and in 1899 he served as entomologist on the Harriman Alaska Expedition. In the course of less than two months, Kincaid collected about 8000 specimens, including 5,500 pinned insects, about 1000 species, the reports on which by Kincaid and others fill two volumes of the published report of the expedition. So important were these results considered that L. O. Howard, chief of the United States Bureau of Entomology, selected Kincaid in 1908 and 1909 to go to Japan and then to southwestern Russia in search of parasites of the gypsy moth; and one of the most important enemies of this pest, the chalcid, *Schedius kuvanae* Howard, was introduced from Japan as a result of Kincaid's investigation.

Since about 1911 Kincaid's name has become associated in the mind of the public of western Washington with the oyster industry and its development in the tide lands of the state. About 1925 he began experimenting with the Japanese or "Willapoint" oyster, and the extensive industry based on the Japanese oyster that has developed in the Willapa Harbor region since about 1931 is very largely the result of his researches. In recent years he has become interested in fresh water plankton of all groups, especially Copepoda. He has also made a study of the bark of maple trees. But to pin Kincaid down to oysters or copepods or maple trees is impossible. He is a naturalist in the broadest sense of the term.



Old Science Hall

From 1902 to 1930 the Departments of Geology, Zoology, Botany, and Bacteriology were housed in this building. In 1931 it was remodeled for occupancy by the Department of English and renamed Vernon Lewis Parrington Hall

In 1937 he was designated *Alumnus summa laude dignatus* by the University Alumni Association, the first to be selected for this honor.

For a number of years after its organization, Kincaid constituted the entire Zoology department. After 1905 he had one additional full time faculty member to help him. This was increased to two in 1911, three in 1922, four in 1927, and six in 1937. Among the men associated with him may be mentioned the following. E. Victor Smith (Ph.D., Northwestern, 1911) has been at the University since 1912. Since 1922 he has been exclusively occupied with the work in physiology, which has undergone considerable expansion in connection with pre-medic, home economics, and nursing students. Nathan Fasten (Ph.D., Wisconsin, 1914) was with the department 1914-20, since when he has been at

Oregon State College, where he has been head of Zoology since 1922. John E. Guberlet (Ph.D., Illinois, 1914) has been with the department since 1923. He and his students have produced a noteworthy series of papers on some of the worm parasites of the Northwest fauna, especially the marine fishes. Robert C. Miller (Ph.D., California, 1923) was with the department 1924-1938. He is the author of papers on the biology of the shipworm and certain aspects of ornithology. In September 1938 he assumed the directorship of the California Academy of Sciences at San Francisco. Melville H. Hatch (Ph.D., Michigan, 1925) has been with the department since 1927 and is author of a series of papers on the taxonomy of the Coleoptera, especially of the Northwest. Arthur W. Martin (Ph.D., Stanford, 1936), a physiologist, joined the department in 1937. Arthur Svihla (Ph.D., Michigan, 1931) joined the department in 1938. He is author to a series of papers on the ecology of mammals.

The Department of Zoology has largely concerned itself with faunistic and acological problems. Among the groups of animals that have been published on may be mentioned the Oligochaeta by Luther C. Altman (Ph.D., 1933), the Plecoptera by Gertrude Hoppe (M.S. 1934), the Cicindelinae, Silphinae, and Chrysomelidae (Coleoptera) by Hatch in collaboration with students, and the Agelenidae (Araneida) by Harriet Exline (Ph.D., 1936), and studies are under way by various members of the Department or students on Tintinnoidea (Protozoa), Trematoda, Acanthocephala, Polychaeta, Copepoda, Ostracoda, Cirripedia, Isopoda, Amphipoda, Natantia, Coleoptera, Araneida, and Amphibia.* The addition of Dr. Martin to the staff has paved the way for the extension of the work in zoology in the direction of experimentation.

Closely related to the work in Zoology is that of Victor B. Scheffer (Ph.D., 1936), who since 1938 has been in charge of a field station maintained at the University by the Division of Wild Life Research of the United State Biological Survey. Dr. Scheffer has a laboratory in Anderson Hall. He is working on the distribution and habits of fur-bearing animals in the Northwest and Alaska, on the economic importance of elk and deer, and on the transplanting of beaver.

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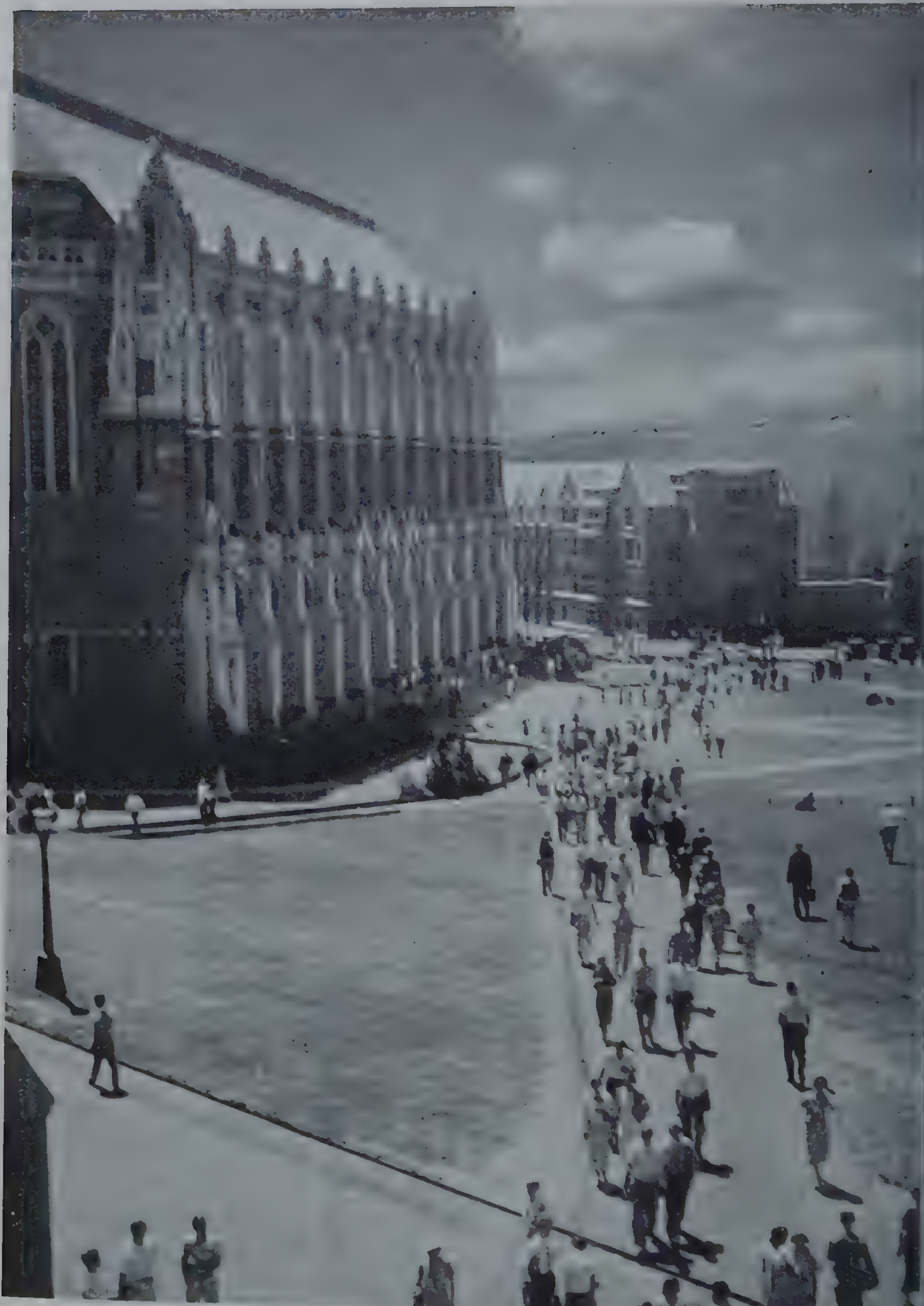
* Cf. below under Puget Sound Biological Station and the Oceanographic Laboratories at Friday Harbor for a list of the groups published on from the Friday Harbor laboratories.



Henry Suzzallo Library with the Orson Bennett Johnson Biological in the Background

The Departments of Geology, Geography, Zoology, Botany and Bacteriology have been housed in the O. B. Johnson Biological Laboratory since its erection in 1930

IV. BOTANY

Homer Redfield Foster was the first Professor of Botany at the University, but he left Seattle in 1903, only two years after the creation of a separate department. He was succeeded by Theodore Christian Frye (Ph.D., Chicago, 1902), who has remained head of the Department to the present time. In 1909 George B. Rigg (Ph.D., Chicago, 1914) came to the department and, in 1911 John W. Hotson (Ph.D., Harvard, 1913), and for over twenty-five years these three men constituted the entire staff. Recently, in 1937, Charles Leo Hitchcock (Ph.D., Washington (St. Louis), 1931), a taxonomist, and in 1938 Herbert P. Riley (Ph.D., Princeton, 1931), a geneticist, were added to the Department.

Among the more important floristic works of the Department of Botany may be mentioned a *Northwest Flora* by Frye and Rigg and special studies on the floras of the Olympic Peninsula and Mt. Rainier by George Neville Jones (Ph.D., 1937). Frye has published numerous papers on the northwestern ferns and liverworts and on some of the groups of mosses, and is now publishing an extensive work on the *Hepaticae of North America*. Hotson's specialty has been the fungi. Among the local groups he and his students have published on may be mentioned

Prof. and Mrs. T. C. Frye

Prof. Frye is Head of the Department of Botany. This picture was taken at Sunrise Park on Mt. Rainier in 1937, on the last day of the Botany Field Trip that Prof. and Mrs. Frye were conducting

Myxomycetes by Henry C. Greene (M.S., 1929), the rusts and the genus *Amanita* by Hotson, the genus *Agaricus* by Hotson and Daniel E. Stuntz (B.S., 1935), and the operculate Discomycetes by Leon Carlton Snyder (Ph.D., 1935). Work is in progress on the Hydnaceae and Agaricaceae.

In addition to these taxonomic studies, Dr. Frye and his students have published papers on plant morphology. Dr. Rigg and his students have published physiological and ecological studies of sphagnum bogs, and papers on plant physiology including some recent work on the physiology of marine plants.

In 1911 and 1912 Dr. Rigg and in 1913 both Dr. Frye and Dr. Rigg were engaged by the United States Bureau of Soils to conduct a kelp survey of the Northwest Coast and Alaska with reference to kelp as a source of potash fertilizer. From 1914 to 1930 Dr. Frye was director of the Puget Sound Biological Station at Friday Harbor. From 1931 to

Woodland Path on University of Washington Campus

The northeast portion of the main Campus has been set aside as a Botanical Preserve, where an attempt is made to retain natural conditions.

1937 Dr. Frye inaugurated summer field trips for students of about six weeks duration to various portions of the Northwest, attaining in one year or another points as distant as Yellowstone National Park, and northern California. In 1938 the trip was in charge of Dr. Hitchcock, and the party went as far afield as Texas and Arizona.

V. Museum

The Museum at the University of Washington has had a checkered course. The first collections were those assembled by the Young Naturalists Society, but the University seems to have acquired some material itself from the Columbian Exposition in Chicago in 1893. O. B. Johnson was designated curator of the Museum 1894-96, Henry Havelock Hindshaw 1896-98, and Edwin C. Starks 1899-1900, but the care of the collections was desultory and at times as much material seems to have been lost as gained. From 1903 to 1909 the collections were housed in the Science Building under the curatorship of the several department heads, and this seems to have been a period of increasing confusion. Then, in 1909, at the time of the Alaska Yukon Exposition on the Campus, Frank Stevens Hall was brought from the University of Michigan and for twenty years, with the assistance after 1913 of Martha Reekie Flahaut, served as curator and director of the Museum. Two of the fair buildings were assigned for museum purposes, extensive exhibits were assembled, and everything seemed rosy. But the fair buildings had not been constructed for permanent occupancy. In 1913 the California Building had to be

Washington State Museum

Previous to 1927 this building was occupied by the University Library abandoned, and a decade later the remaining Forestry Building was closed to visitors as unsafe, so that for four years there were no public exhibits. In 1927 the Museum was assigned the quarters it now occupies, a building just previously occupied by the University Library. Here, at first under the direction of Mr. Hall and, since 1929, under the direction of the Head of the Department of Anthropology, Erna Gunther (Ph.D., Columbia, 1928), exhibits have once more been opened up.

One of the most important accomplishments of the Museum was the organization by Mr. Hall in 1920 of the Northwestern Bird and Mammal Society. This group was really a revival of the Caurinus Club, and informal ornithological club organized in Seattle about 1902 by S. F. Rathbun, J. Hooper Bowles, Wm. Leon Dawson, Frank R. Renick, D. E. Brown, Dr. Clinton T. Cooke and others interested in birds. For many years this group had, however, been active. about forty members were obtained for the new organization the first year. Publication of *The Murrelet, a journal of Northwestern Ornithology and Mammalogy* was commenced, a *Check-list of Washington Birds* by E. A. Kitchin was published in 1934.

While the zoological and ethnological exhibits of the Washington State Museum in no way compete with those of the great museums, they have contributed materially to the enjoyment and education of untold numbers of students and visitors. Especially within the last decade have school children from Seattle and neighboring communities been making use of the Museum's facilities in increasing numbers. Quantities of traveling exhibits have, moreover, been prepared, which, for a trifling transportation charge, can be borrowed by any teacher in the state for use in her class.

On the research side, the facilities of the museum have primarily been used, so far as botany and zoology are concerned, to build up an extensive herbarium extending back to the collections of C. V. Piper and L. F. Henderson* and now housed in the Department of Botany, a conchological collection derived from Brooks Randolph and the Young Naturalists Society, and extensive collections of bird and mammal skins.

VI. Puget Sound Biological Station and Oceanographic Laboratories at Friday Harbor.

Seashore work in biology at the University goes back to the eighties when O. B. Johnson used to take groups of students for a few weeks in the summer to places like Rocky Point, near Bremerton, and Lillewaup

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* See Biologist XV, 1933, pp. 5-8, 48-49 for an account of Henderson.

Falls on Hoods Canal, or to the nineties and the dredging trips of the Young Naturalists. The Friday Harbor site was explored by Trevor Kincaid in 1903. Summer school instruction was initiated in 1904 by Kincaid in zoology and T. C. Frye in botany in an old cabin on the property of Captain Andrew Newhall, a half a mile from the town of Friday Harbor.

From 1906 to 1908 the station occupied an unused cannery building adjacent to the Newhall home, and in 1909 a small dock building. That fall and winter a building was erected on some property given by Captain Newhall about half a mile south of town, which for thirteen or fourteen years served to house the work of the institution. The present site, a tract of 486 acres about two miles by road northeast of Friday Harbor, was ceded to the University by the Federal Government in 1922. Here, between 1923 and 1928, ten buildings were erected, which, with tents for the occupancy of the persons in attendance, constitute the present equipment of the station.

The Old Pudget Sound Biological Station at Friday Harbor
This building was constructed for the use of the Station in 1910. In 1923 and 1924 new laboratories were erected on the opposite shore of the bay.

Kincaid was in charge of the station in 1904, 1906, and 1910-13. Frye was in charge in 1905, 1907, 1908, and from 1914 to 1930. After the session of 1930 the Puget Sound Biological Station was discontinued and the physical plant and summer instruction was taken over by the Oceanographic Laboratories, under the directorship of Thomas G. Thompson, professor of chemistry.

The staff of the station has usually numbered six or seven, elected in part from the University and in part from other institutions. Among visiting biologists on the staff at one time or another may be mentioned Prof. H. H. Brode of Whitman College, H. H. Gran, of the University of Oslo in Norway, E. J. Lund of the University of Texas, V. E. Shelford of the University of Illinois, E. B. Powers of the University of Tennessee, C. McLean Fraser of the University of British Columbia. The courses have consisted of invertebrate morphology, embryology, and ecology in zoology and in marine algae in botany, with other special courses offered from time to time.

Oceanographic Laboratories at Friday Harbor

Botany Laboratory (left) and three Zoology Laboratories in foreground with the Mess Hall in the background.

The earlier years were given over to a preliminary survey, but, beginning with the issuing of the *Publications of the Puget Sound Marine* (after Vol. I, *Biological) Station* in 1915, a respectable start was made on a study of the fauna and flora. A notable series of papers on algae was produced under the stimulus of Director Frye, including taxonomic surveys of the brown algae by Walter C. Muenscher, the red algae by H. O. Kylin, the plankton diatoms by H. H. Gran and E. C. Angst (Ph.D., 1929), and the desmids by Caroline S. and Laura B. Moore. Of the taxonomic papers on animals, there may be mentioned: hydroids by C. McLean Fraser; polyclads by Daniel Freeman; the helminthological studies of J. E. Guberlet and his students, Helana J. Werby (Ph.D., 1937), Florence Folda (M.S., 1928), John Hart (Ph.D., 1935), Lowell C. Lloyd (Ph.D., 1936), and Kelshaw Bonham (Ph.D., 1937); Bryozoa by Charles H. and Elise O'Donoghue on the basis of material collected by Kincaid; Echinodermata by Mildred Bush; shelled Mollusca and Branchiopoda by Mrs. Ida Shepard Oldroyd; crabs by Evelyn Way (M.S., 1917); Pinnotherid crabs by Wayne W. Wells (Ph.D., 1931); hermit crabs and Callianassidae by Belle A. Stevens (Ph.D., 1931); Araneida by Leonard G. Worley; Pycnogonida by Harriet Exline (Ph.D., 1936); fishes by E. C. Starks and Leonard P. Schultz (Ph.D., 1932); and birds by Ellsworth D. Lumley (B.S., 1929), F. S. Hall, and Robert C. Miller.

Among other important research conducted before 1931 must be mentioned the physiological studies of E. J. Lund, the ecological studies of V. E. Shelford, E. B. Powers, and their students, and the beginning of Thomas G. Thompson's study of ocean water.

Since the merging of the station with the Oceanographic Laboratories, the work has been under the control of the Graduate School. In addition to continuing the previous biological work, there has occured an increased emphasis on the physical and chemical factors of the marine environment. Ecological studies of the zooplankton have been carried out by Martin W. Johnson (Ph.D., 1932) and R. C. Miller and of the phytoplankton by Lyman D. Phifer (Ph.D., 1932). Studies in marine bacteria have been initiated by B. S. Henry and his students, in the physiology of marine plans by G. E. Rigg and his students, and in the biochemistry of marine organisms by Earl Norris. A tidal station has been maintained in cooperation with the United States Coast and Geodetic Survey, and various meteorological observations have been made, including data on total solar radiation derived from a pyroheliometer, in cooperation with the United States Weather Bureau.

VII. PALEONTOLOGY

The paleontological work at the University has been in the hands of Charles Edwin Weaver (Ph.D., California, 1907) since he became a member of the Department of Geology in 1907. Weaver's paleontological studies have been largely stratigraphic, on the Tertiary invertebrates of Washington and California. From 1919 to 1925 he was on leave doing similar work in South America, and he has published a large volume on the Jurassic and Cretaceous fauna of west central Argentina. At the present time he is working on a monograph of the Tertiary invertebrates of Washington.

VIII. ANATOMY

The work in human anatomy at the University takes its rise from the appointment of Hjalmar Lauritis Osterud (M.A., 1910; Ph.D., Minnesota, 1921) in the Department of Zoology from 1911 to 1917. Osterud taught courses in histology and embryology and, in 1915 and 1916, summer school courses in gross anatomy. In 1917 this work was taken over by John Locke Worcester (M.D., Birmingham, 1900), who, after his first quarter on the campus, was made head of a separate department.

The anatomy courses have formed an important part of the instruction in pre-medical work, nursing, physical education, and physiology. Moreover, in recent years, the department has been able to assist local members of the medical and dental profession by allowing various study groups the facilities of the laboratories for evening classes.

IX. FISHERIES

The work in fisheries at the University originated in the years 1916-19 in the Department of Zoology in courses in ichthyology taught by Trevor Kincaid and in pisciculture by E. Victor Smith. From 1919 to 1930 the curriculum in fisheries was constituted a College with John Nathan Cobb (1868-1930) as dean. Under Cobb the relationship with Zoology remained close. Kincaid continued for several years the instruction in ichthyology and shell-fish, and the course in fish diseases has always been taught by a zoologist—since 1923 by John E. Guberlet. Considerable emphasis was placed on certain technological aspects of the work, two or three members of the staff being concerned with pisciculture and cannery operations and technique.

In 1924 there was established by treaty between Canada and the United States the International Fisheries Commission for the investigation and control of the halibut fisheries of the North Pacific Ocean. Due to its situation as the home port of a large fraction of the halibut fishing fleet, Seattle was selected as headquarters for the scientific work of the Commission. In cooperation with the College of Fisheries laboratory space was assigned the Commission and, in 1925, William F. Thompson (Ph.D., Stanford, 1931) was placed in charge. With the assistance of a staff of four or five competent biologists, much progress has been made in understanding and controlling the exploitation of this valuable fishery.

In 1928 Leonard Peter Schultz (Ph.D., 1932) took charge of the work in ichthyology. In the course of the eight years before he left the University to become Curator of Fishes in the United States National Museum, Schultz conducted an extensive survey of the piscifauna of the state, culminating in the publication in 1935-36 of a bibliographical catalogue and in 1936 of a key to the fishes of Washington and Oregon.

Following the death of Dean Cobb early in 1930, the College of Fisheries was reorganized as a School. The work in fisheries technology was eliminated, and the administration tended Director Thompson of the International Fisheries Commission the Acting Directorship of the School and the following year secured James E. Lynch (Ph.D., California 1929), a parasitologist, to teach courses in economic invertebrates. In his dual capacity, Thompson made the fisheries curriculum the coordinating link between zoology on the one hand and the practical research and administration work of various governmental fisheries agencies on the other, with emphasis on the sort of ecological, life-history, and statistical work in which the men employed by these agencies are engaged.

The fisheries group on the Campus was still further augmented in 1931 when the United States Bureau of Fisheries moved its Pacific Coast laboratory from Palo Alto, California, to a specially constructed three story brick laboratory directly across the Montlake Bridge from the University. Since 1934, Frederick A. Davidson (Ph.D., Chicago, 1927) has been Director of the laboratory and in charge of the Division of Scientific Enquiry. He has a scientific staff of fifteen working under him on problems connected with the salmon and the herring in Alaska and the salmon in Washington, Oregon, and Idaho. Frederick J. Foster with a scientific staff of two is in charge of the Division of Fish Culture, supervising the fish hatcheries of the Bureau of Fisheries throughout the entire western United States and working on problems of aquaculture. Roger W. Harrison (M.S., Geo. Washington, 1928), with one scientific assistant, is in charge of the Division of Fisheries Industries, working on the analysis of fishery products with reference to their nutritional value.

In 1935 the Washington State Fisheries Department established a laboratory in one of the Fisheries Buildings with W. M. Chapman (Ph.D., 1937) and Milner B. Schaefer (B.S., 1935) in charge with one scientific assistant. Dr. Chapman has worked on salmon and Mr. Schaefer on various aspects of the biology of surf smelt, Japanese oyster, and razor clam. In 1936 the Washington State Game Department established a laboratory, likewise in one of the Fisheries Buildings with Clarence Pautzke (B.S., 1932), in charge, and with two or three assistants. They have been engaged in investigations on trout.

Finally, as a result of a treaty entered into in 1937 between the United States and Canada, the International Pacific Salmon Fisheries Commission was established with Dr. Thompson as director.

In accordance with the policy of cooperation between the University and these outside agencies, most of the scientists on their staff are appointed as non-salaried lecturers in the School of Fisheries, giving them the facilities of the Campus and giving the students and staff members of the College and others the benefit of their experience in conducting seminars, research work, etc. Moreover, these agencies give students and former students in Zoology and Fisheries part or full time employment. At the present time nine or ten graduates of the School of Fisheries are being employed by the Washington State Fisheries Department, seven or eight by the Washington State Game Department, and ten or eleven students were given summer employment in 1938 by the International Pacific Salmon Fisheries Commission.

X. BACTERIOLOGY

Work in Bacteriology at the University dates from 1906, when John Weinzirl (Ph.D., Wisconsin, 1906) joined the Department of Botany. A separate Department of Bacteriology was not created until 1915, and Dr. Weinzirl remained its head until his death in 1935. Weinzirl's main interest remained the bacteriology of food contamination until about 1926, when he became Director of the Alice McDermott Foundation. This fund was established in 1924 by the bequest to the University by Mrs. Josephine McDermott of about $100,000, the income from which was to be used for researches leading to the improved treatment or cure of tuberculosis or cancer. The University elected to study tuberculosis, and Dr. Weinzirl, with the assistance a portion of the time of James Durward Thayer (Ph.D., 1937) and others investigated the desensitization to tuberculosis of guinea pigs.

Weinzirl remained the only staff member of the department until 1923, when he was joined by Rachael E. Hoffstadt (Ph.D., Chicago, 1915; Sc.D., Hopkins, 1923), whose principal work is with pathogenic bacteria and viruses. Bernard S. Henry (Ph.D., California, 1931) joined the department in 1931 taking over the headship of the department and the directorship of the McDermott Foundation on Dr. Weinzirl's death. In addition to the work on tuberculosis, Dr. Henry is interested in the physiology of marine bacteria and the bacteriology of fermentation. Recent additions to the department are Russel S. Weiser (Ph. D., 1934) in 1936, interested in immunology and cancer pathology, and Erling J. Ordal (Ph.D., Minnesota, 1936) in 1937, interested in industrial bacteriology and the enzyme mechanism in bacteria.

Recently the Departments of Bacteriology, Home Economics, and Chemistry have cooperated to offer a Curriculum in Food Technology leading to a degree of Bachelor of Science in Food Technology.

Somewhat related to the work in Bacteriology is that of the Frozen Pack Laboratory of the United States Bureau of Chemistry and Soils in charge of Mr. H. C. Diehl. A laboratory was established in Seattle in 1931, but it was only in 1938 that it occupied a laboratory on the Campus. With the aid of three scientific assistants, Mr. Diehl is investigating the problems surrounding the preservation of fruits and vegetables by freezing: the development of varieties best suited to this method of preservation, the microbiological content of the frozen product, the effect of freezing on the product, etc.

XI. Forestry

The first instruction in forestry at the University was by the late Edmond S. Meany, one of the Charter members of the Young Naturalists Society. For over a decade, from 1896 to 1907, the tall gaunt figure of Professor Meany could be seen conducting classes of students around the campus initiating them into the smattering of knowledge that passed in those days for forestry. Eventually Meany relinquished this work to devote his entire time to the Department of History, and the College of Forestry was organized under the deanship of Frank G. Miller (M.F., Yale, 1903). In 1912, Miller resigned and was succeeded by the present Dean of the College, Hugo Winkenwerder (M.F., Yale, 1907), who had been on the Campus since 1909. The College occupied the present Forest Products Laboratory in 1921 and the adjoining Alfred H. Anderson Hall in 1926. The year 1921 saw the commencement of the publication of the *University of Washington Forest Club Quarterly,* in which many articles of timely interest to foresters have appeared.

Dean Hugo Winkenwerder
of the
College of Forestry

Under Dean Winkenwerder's administration an important portion of the work of the college has been technological rather than biological, since the initial problems facing the forestry profession in the Northwest concerned the removal and use of rather than the cultivation, protection, and detailed biology of trees. Of recent years, however, this latter work has been coming more to the fore.

There is the work of Bror Leonard Grondal (M.S.F., 1913), who has been with the College since 1913, on the ultimate structure of wood and its penetration by fungi, making use of very high power photomicrographs. Axel J. F. Brandstrom (B.S.F., 1919), on the faculty from 1928 to 1931, developed the method of selective logging for Douglas fir that is now being extensively employed. Ellwood Scott Harrar (Ph. D., Syracuse, 1936), on the staff from 1928 to 1936, was co-author with Wm. H. Harlow of Syracuse University of one of the most widely used textbooks of dendrology. He is now associate professor of forestry at Duke University. Walter H. Meyer (Ph. D., Yale, 1929), with the College since 1936, is the author of outstanding papers on the growth of western hemlock and ponderosa pine.

The Pack Demonstration Forest is a tract of approximately 2,000 acres located at La Grande, Washington, donated to the University by Charles Lathrop Pack Forestry Trust about 1927. It is used for demonstration and instructional purposes and a number of areas for experimentation on rate of growth, etc., are maintained. Since 1937 experimental work on forest insects has been carried on at the Pack Forest in cooperation

Prof. Bror L. Grondal
of the
College of Forestry

with the Forest Insect Laboratory at Portland, Oregon, in charge of Mr. F. P. Keen of the United States Bureau of Entomology and Plant Quarantine.

Alfred H. Anderson Hall with the Forest Products Laboratory in the Background
The College of Forestry is housed in these buildings.

XII. Arboretum

In 1934 the city of Seattle gave the University a 99-year lease to a tract of 267 acres in Washington Park for use as an Arboretum, and Dean Winkenwerder was made Acting Director. To date over a million dollars of P. W. A. funds have been employed in the development of the project and there are now about four thousand species and varieties of trees and shrubs growing on the grounds. John H. Hanley (Ph.D., Illinois, 1938), assistant professor attached to the College of Forestry and the Department of Botany, has just been appointed director. The mild equable climate of Seattle is unusually favorable for such a project, and with proper support and management, the Arboretum should develop into one of the leading institutions of its type in the world.

XIII. Pharmacy

The School of Pharmacy, since 1913 the College of Pharmacy, was established by the Board of Regents as early as 1894. It was not, however, until the appointment of Charles Willis Johnson (Ph. D., Michigan, 1903), the present Dean of the College, in 1903, that the entire time of a single instructor was given to this work. Graduate work was instituted in 1912, and work for the doctorate since 1925. The staff has grown until there are at present, in addition to the Dean, five professors, as well as instructors and assistants.

Dean Johnson, in addition to directing the work of the College, has been State Chemist since 1909, and since 1920 has been a member of the revision committee of the United States Pharmacopeia. Among other past and present members of the staff may be mentioned the following: Eldin Vern Lynn (Ph.D., Wisconsin, 1918), in the pharmacology department from 1920 to 1934 and now at the Massachusetts College of Pharmacy, was author of an extensive series of papers on pharmaceutical chemistry. Forest Jackson Goodrich (Ph. D., 1927), on the staff since 1919 in pharmacognosy, is author of a series of papers on certain northwestern plants. Henry August Langenhan (Ph. D., Wisconsin, 1918), in the College from 1922 to 1938, has published a long series of papers dealing with practical problems in the dispensing and manufacturing of pharmaceuticals and analysis of drug plants. Louis Wait Rising (Ph. D., 1929), with the College since 1934, has written a series of papers on toxicology, pharmaceutical chemistry, and professional pharmacy. James M. Dille (Ph. D., Georgetown, 1935), in the Department of Pharmacology since 1936, is active in research on the pharmacology of the barbiturates.

Dr. Charles W. Johnson
Dean of the College of Pharmacy

A noteworthy feature of the College is the Garden of Medicinal Plants, established in 1911, and since 1922 in charge of Mr. Ludwig Metzger, a German-trained gardener. In 1936 the garden occupied about eight acres and contained 836 species of plants classified as follows: Plants Grown in Ancient and Medieval Gardens, Plants Native to Washington or the United States, Kitchen Herbs, Plants of Known Medicinal Properties, Plants Poisonous to Man or Animals, and an Experimental Plat.

Garden of Medicinal Plants

Over 800 species of plants are grown here under the supervision of the College of Pharmacy

XIV. BIOLOGICAL CHEMISTRY

Work in biological chemistry is given in the Department of Chemistry and was offered from 1907 to 1918 by William Maurice Dehn (Ph. D., Illinois, 1903), and from 1918-22 by Arthur W. Barton (Ph. D., Northwestern, 1918). Since then the work has been continued from 1922-24 by Zalia Jenks Gailey (Ph. D., Yale, 1921), from 1924-27 by Lyman C. Boynton (Ph. D., Columbia, 1924), and since 1927 by Earl R. Norris (Ph. D., Columbia, 1924). Since 1933 Dr. Norris has likewise been on the staff of the Oceanographic Laboratories, and his researches, previously largely confined to vitamin studies, have been extended to the biochemistry of marine life.

XV. NUTRITION.

The work in nutrition in the School of Home Economics was first offered in 1924 and 1925 by Martha Koehne (Ph. D., Yale, 1928). Since 1925 it has been in charge of Jennie Irene Rowntree (Ph. D., Iowa, 1929), who has been interested in vitamin studies and other nutritional problems. In addition Dr. Rowntree has been concerned with the application of the science of nutrition to the dietry problems of the people of state, with special reference in some measure to the nutritional requirements of persons on relief.

XVI. OCEANOGRAPHY

The Oceanographic Laboratories were organized in 1930 under Thomas Gordon Thompson (Ph. D., 1918), professor of chemistry. Its personnel is composed of members from the Departments of Botany, Chemistry, Physics, Zoology, Bacteriology (since 1934), and Geography (since 1937), and represents an endeavor to apply these various sciences to a study of the sea. The work offered is exclusively graduate in nature and is supplemental to that of the various departments involved.

In 1931 it took over the physical plant of the Pudget Sound Biological Station and has since then continued the more important aspects of the work of the station, with the elimination of undergraduate instruction, but with increased emphasis on the physico-chemical factors of the marine environment.

In 1932 there was completed on the Seattle campus the Oceanographic Laboratory. $200,000 of the $250,000 used to build and equip the building was the gift of the Rockefeller Foundation. The building is supplied with elaborate aquarium tanks with circulating sea water at the proper temperature and represents a notable extension of the laboratory facilities of the several departments involved.

Oceanographic Building

Erected in 1932 with the aid of funds given by the Rockefeller Foundation.

The Rockefeller Foundation likewise granted a sum of $45,000 in 1932 for the construction of the Motorship *Catalyst*, a seagoing laboratory for oceanographic research of some 92 tons gross. Length over all is 74′ 4″. The boat is driven by a Washington-Estep full Diesel engine of 120 horsepower at 450 R.P.M., giving a speed of 8.2 knots and a cruising range of 3,500 miles. Two electrically driven winches control the sampling cables: one with 4,500 meters of 5/16-inch stainless steel cable for taking plankton and water samples, the other with 600 meters of one-inch galvanized cable used in bottom dredging. The laboratory contains working space for seven persons, each section equipped with 110 A.C. and D.C. and one variable voltage outlet and an outlet for Flamo gas. The laboratory also has compressed air and a hood with forced ventilation. Sleeping quarters are provided for sixteen. Eight may be served at one sitting in the galley.

The *Catalyst* has been used primarily for oceanographic investigations in Pudget Sound, Juan de Fuca Straits, and the off-shore waters from Oregon to British Columbia. It has, however, been employed for some limnological work on Lake Washington. Since 1932 three trips have been made to southeastern Alaska, and five to the Queen Charlotte Islands, and in 1935 the ship was taken as far south as San Francisco. The water and plankton samples and bottom hauls secured by the *Catalyst* have proven of great scientific interest.

Motorship "Catalyst"
The seagoing laboratory of the University of Washington

An important feature of the work in Oceanography has been in cooperation with the United States Coast Guard and the United States Navy. Beginning in 1933, graduate students or members of the staff have accompanied various naval or Coast Guard boats to points in Alaska or the Hawaiian Islands, making continuous series of water and plankton samples on the way, and many bottom samples. In 1938 Director Thompson with Mr. Joe R. Goodman (B.S., 1934) went in this way as far as Point Barrow on the Arctic Ocean.

XVII. Acknowledgments and Bibliography

Most of the data on which the present report is based have been derived personally through interviews or the study of unpublished memoranda or reports. The published sources are few. The University Catalogues and *American Men of Science* give data on personnel. Faculty bibliography is given in Kelly, *Publications of the University of Washington Faculty November*

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For an account of the Washington Chapter of the Society of the Sigma Xi see *Sigma Xi—half century record and history—1886-1936*, pp. 637-655. For the Psi Chapter of the Phi Sigma Society see The Biologist X(2), 1928, pp. 25-26 and numerous subsequent numbers. For the Research Society see Meany, Bull. Amer. Assoc. Univ. Prof. XIII, 1927, pp. 589-590.

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Accounts of The Puget Sound Biological Station and Oceanographic Laboratories have appeared in the Biologist XII, 1930, pp. 5-20; XIII, 1932, pp. 142-150; XVIII, 1937, pp. 160-170. Professor Thompson has published an account of the Oceanographic Laboratories in The Collecting Net X, 1935, pp. 281-284 and an account of the Motorship *Catalyst* in Jour. Chem. Educa. XIII, 1936, pp. 302-309.

An account of the Museum has been published in Bull. Univ. Wash. State Museum Ser. Bull. 1, 1910, 10 pp.

A series of brief accounts of the early history of the College of Forestry are in Univ. Wash. Forest Club Quart. IV (3), Nov. 1925, pp. 7-52, and the history of the College of Pharmacy is sketched very briefly in Bull. Univ. Wash. 505, 1938, pp. 4-5.

When no institution is mentioned in connection with a degree, the University of Washington is understood.

Finally, appreciation is expressed to Mr. Clyde A. Robinson, publications manager of the Associated Students of the University of Washington, for the loan of most of the cuts used to illustrate this article.

MELVILLE H. HATCH
University of Washington

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ORIGIN AND DEVELOPMENT OF THE CELL THEORY

and its Application in Modern Biology, Cytology and Medicine

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I.

THE privilege which is mine this afternoon is akin to the pleasure which an appreciative soul would find if the task were assigned to him of discussing any one of the great epic writers, if Homer and Virgil and Shakespeare and Milton and Goethe and Schiller could all be gathered together in one assemblage. For the mention of the name of Theodor Schwann evokes in one's imagination the forms of the giant of biology. What if unlike the giants of literature, these giants lived almost contemporaneously and created an understanding of the processes of life within the limits of scarcely a century, thus contributing within the span of three human life times more to our understanding of life and its processes than have been contributed within the spans of fifty human lives previous to the nineteenth century. The giants of literature were scattered through the centuries; the giants of biology worked side by side, each contributing not fragments but huge granite boulders of thought and insight and penetrative understanding to the pyramid of biologic science that has risen and is still rising skyward from the barren deserts of ignorance. If Grecian fable tells of one Atlas who bears upon his shoulders the weight of the world, biology has many such, and not the least of them is Theodor Schwann.

Are we exaggerating? Johannes Peter Muller was born in 1801 and died in 1858. Within the relatively short space of fifty-seven years, there were enacted the dramas and tragedies associated with the rise and fall of many a great and nearly great name; there played the struggles and strifes of mental clashes that resulted in the emergence of a new science which began as a separate activity of the human mind, which then leaned upon physics and chemistry and finally, proved the right to its own autonomy and which through the struggles and strifes, succeeded in impressing an indelible imprint upon every human activity and interest from the solitary pursuit of laboratory study to international relations of government, from the study of atomic structure to the generalizations of education, from the minutiae of nutritional function to the vast principles underlying agricultural economics, from the details of the learning process in the protozoa to a philosophical world viewpoint.

Associated with the name of Johannes Muller, the teacher, we find, as his pupils, students like Virchow, Henle, Wagener, Helmholtz, DuBois-Reymond, Claparede, Ludwig, Volkmann, Reichert, Lachmann, Kolliker, Remak, Lieberkuhn, Haeckel, and others of scarcely less fame and the subject of our memoir this afternoon was associated in thought and activity with each one of these men, who, each in his respective field, has been a builder of foundations, no less than a finisher of lofty edifices. One cannot but stand in speechless admiration before the stature of a man who stimulated, if he did not create the genius of such a mental progeny. No wonder that Theodor Schwann found in such associations the stimulus to his own genius. One cannot but speculate on the phenomena and wonder how one man could achieve so much. It has been suggested that this was because he never dogmatized, because he spoke only of his own views with emphasis, it is true, but with humility, and because he encouraged his students to form their own opinion, to follow their own bent wherever their special genius might lead them and because perhaps, he had the deepest respect for the achievements of others. Theodor Schwann had the unusual privilege and advantage of having his own mental guide pronounce the achievement of his own pupil as the basic concepts upon which he, Johannes Muller, the teacher, based his teachings in influencing succeeding generations of his scholars.

But Schwann has for us this afternoon another significance. Both he, the pupil, and Johannes Muller, the teacher, were unswerving Catholics in religion and what is more important still, they were unswervingly Catholic in their lives. Pathfinders thought that both, in penetrating into the regions of the unknown and the unexplored, they not only found their religion and their religious life no obstacle to progress but rather both found in their faith and in its teachings, the inspiration to self-dedication to science and safeguards in the philosophy which grew out of their laboratory studies. In their souls, there grew up no such conflict between science and faith as characterized the struggles in other countries. England, for example, in the two or three decades succeeding Muller's death, struggled through which Schwann lived while occupying a professorial chair at the Catholic University of Louvain and later, at the University of Liege.

As has been pointed out so often, science conflicts with theology, not while the scientist is working with his microscope or his scalpel or his test tubes, but when science or rather, the individual scientist, trespasses beyond the limits of the objectives which he cannot but have set for himself as a true scientist. Not that the human mind can or should be coerced within artificial barricades but that the subject which that human mind, whether that of the scientist or the theologian must think about, is too great to be studied in all its countless facets by the same methods. The development of the tadpole and the law of diminishing returns and the mystery of the Trinity must be approached when studied by the human mind, from diverse paths in diverse manners by the employment of diverse methods and through the use of diverse instruments. But in the synthesis of science and religion, there is more than this negative result to be gained. One, in fact, must lend strength to the other, and Muller and Schwann have both proved by their lives that the definitions of the Ecumenical Councils and the divine character of papal dignity are no hindrances to the freedom of the human mind and no obstacles to the freedom of research.

And thirdly, Theodor Schwann has for us here in a Jesuit University, another significance which we proudly and reverently and humbly cannot but emphasize. Theodor Schwann was a pupil of the Jesuits at Cologne, as we are pupils of the Jesuits, and found in that association and influence, the basis of his life work. His was not the worry that his mental freedom would be curtailed by the restraints of rigorous logic or that his character would be warped by the sophistries of Jesuitry as so many others claim to have feared who know nothing of Loyola or Xavier. And may we not trace even in the life of his teacher, some influence of Loyola in the associations that are definitely detectable in Johannes Muller's activities. Schwann developed in himself through the insistence upon the objective of life which was given to him in his early Jesuit training and in the breadth of interest communicated to him through the program of studies of the Jesuit Ratio Studiorum that steadfastness, mental security and solidity of character which characterized him throughout his entire life.

II.

To understand Schwann's achievements, it would be well to turn back the pages of the history of science at least for a quarter of a century. In the laboratories of the universities towards the end of the eighteenth century, Bichat's concept of life and his tissue theory held sway over all biological thinking. Incidentally, we might recall in passing, that Bichat's baptismal names were Marie Francois Xavier, through which name there is created another link between Schwann, whom we commemorate today and his precursor of the University of Montpellier, for Bichat too was a Catholic, a pious and devoted Catholic, if we may believe the evidence afforded by the first name of which we are told, he was deeply proud and a Jesuit in spirit and sympathy, if again we may believe the evidence derived from the fact that he was called Francois Xavier. For Bichat, the body of all organisms is built of tissues. He viewed with critical disfavor, the concept of the older biology that the structural units of the body are the organs, a viewpoint which was developed through an over emphasis upon the findings of gross anatomy. Bichat pointed out that in each individual organ, first of all, there are individual tissues and secondly, that these various tissues may have individual life distinct from that of the various other tissues with which a particular tissue may be associated. His classical illustration is this, that ''in abdominal catarrh, it is the mucous membrane that is affected and not the muscles of the abdominal wall; in inflammation of the brain, it is in most cases, the cerebral membrane that is the seat of the disease'' (Nordenskiold, p. 1348). And so for Bichat, to understand the processes of life, it is required to ''disintegrate the organ'' so that one might thus reach a better understanding of the real elements of life. Hence too, he labored in reaching an accurate classification of tissues with rare insight into differences of structure and function; he established twenty-one tissue-categories but again with an even rarer insight, he points out that these various tissues are by no means alike everywhere and in every part of the body, rather invariably both structure and function of a particular tissue is modified by its association with other related tissues in the same organ.

III.

It was this comprehensive and generally accepted viewpoint which for the time being, marked the boundary of biological thinking and continued as it were, to set limits to biological teaching. Just one hundred years ago, the year in which Schwann published his epoch-making and pathfinding work on the unity of animal and plant tissues as shown by their identical basic structure. From 1790 to 1839 the viewpoints which Bichat pressed were in part traditional but in a still larger part, entirely new. It must be remembered that microscopic science, despite the years since Leeuwenhoek, was still in its infancy largely because the use of the microscope not for magnification but for differentiation, had reached its farthest possible development. Achromatic lenses were still unknown. The enthusiasm of the previous hundred years had given way to a recognition of the inability of opticians and instrument makers to overcome the one great obstacle, chromatic aberration. When this difficulty was corrected, the microscope revealed new worlds and when it became possible to make lenses with glass of different indices of refraction and thus to correct spherical aberration, the present perfection of the microscope became possible. There are hints as far back as the day of Aristotle that living things are composed of basic units. An early English biologist, two centuries previously, as well as Malpighi and Leeuwenhoek at about the same time, had foreshadowed in vague terms which, nevertheless, indicated some insight into the truth, that plants at least were built up fundamentally of cells. Caspar Wolff in the second half of the eighteenth century and Oken in the early part of the nineteenth century, indicated some suspicion that animal tissues are built up of the same structural units. It was only with the work of Schleiden however, that the immediately preliminary steps for Schwann's generalizations could be scientifically and safely taken.

Of Schleiden, much might be said but at this point, it is sufficient to indicate that Schleiden's glimmering understanding of the place of the nucleus in the cell was undoubtedly the immediate inspiration for the successful formulation of Schwann's conclusions. Whether or not such a conversation ever took place between Schleiden and Schwann as Robinson narrates in his ''Pathfinders in Medicine,'' it is hard to say. It might well have taken place. He pictures the two friends in a beer garden in Berlin when Schleiden announces to his friend his conclusion that the nucleus plays a chief part in the vegetable cell. He refers to the work of Robert Brown in the course of the conversation and then reminds Schwann that he expects to trace back every plant embryo to a single nucleus in its cell.

This remark reminds Schwann that he has seen a similar structure in the cells of the dorsal cord of embryos and that he has traced similar structures in the vertebrate notochord. Schleiden and Schwann both thereupon retired to Schwann's laboratory after having drunk a toast in beer to the memory of Robert Brown and when Schwann exhibited his slides to the chorda dorsalis of the tadpole, they were both convinced that the structures were identical. Thereupon, it was Schwann who is reported to have said ''It must follow in consequence that the conception of the cell structure as fundamental in organisms which we have accepted for plant structures must be extended also to the animal and the cell is the unit of all organic structure.'' It is more than likely that this conversation is simply a dramatization of the exchange of ideas which took place over a prolonged period of time between the two friends. Nevertheless, it summarizes what was in all likelihood, the actual thinking of these two men who were so different yet who are now credited by the voice of history as both influential in arriving at one of the most far-reaching conclusions of science.

It must be admitted that the conceptions of the structural units in those early days were extremely primitive when compared with our present-day concepts of the complexity of the cell. As a matter of fact, it was believed that the cell wall which after all was the element most impressive to these early observers, was regarded by them as the real vital constituent and that the content of the cell was thought to be of relatively much smaller importance. Their attitudes are sufficiently indicated by the choice of the word ''cell'' to indicate their understanding. Further insight into those early ideas is given by the speculations of Schwann with reference to the formation of the nucleus which was thought to be a temporary structure which appeared and disappeared and which could be reformed from the more or less homogeneous cell content by processes little understood and clumsily described.

If anyone would judge from this, however, that Schwann had no insight into the importance of the cell content or that he failed to appreciate the unique importance of the nucleus, he would be far wrong for no other than Rudolph Virchow in his appreciation of Schwann written at the time of the latter's death, quotes the following sentence which has been overlooked by too many commentators and which might be said to be a foreshadowing not only of the subsequent conclusions but which also embodies a viewpoint which will give direction to cytological researches for many years to come. ''We must in general,'' so Schwann writes, ''ascribe to the cells a measure of autonomous life, that is, the combinations of molecules as they are contained in the individual cells are such that they liberate energy which enables the cell itself to synthesize new molecules. Hence, the reason for nutrition and growth lies not in the organism as a whole but rather in the individual elements of which is composed the cells.''

No less a person than Johannes Muller himself, in his great book on physiology not only refers frequently to the work of his pupil but devotes an entire chapter to the influence which Schwann's conception is expected to have on the future biology and particularly of physiology and of pathology. Similarly, it must not be overlooked that Schwann foresaw, at least in principle, the influence which his conception would have upon the future of genetics and embryology. He says, for example, "The development of the statement that there is an unified general developmental plan for the production of all organisms and that cell division is the fundamental underlying process," is the central thought in the theory which he developed. It is unnecessary to say that after a hundred years of intensive and extensive research we have succeeded only in unraveling in part, the full content of Schwann's ideas but fundamentally, all subsequent research has simply confirmed the scientific worker in the full reliability of Schwann's principle.

If all of this today is a matter of elementary and general knowledge, its sensational character at the time of Schwann's first enunciation cannot be overlooked. Today's truisms of science are the discoveries of yesterday. The criterion for the evaluation of a discovery, however, is not its newness but the influence which it exerts upon subsequent research. Measured by this standard, it may be doubtful whether in the entire field of structural and functional biology, a single concept has more profoundly influenced biological science. Leading up to Schwann's work, of course, the morphological viewpoint developed by the earlier workers who suspected the existence of cell structure either in plants alone or in animals and plants, could not but serve as the anatomical basis for Schwann's work.

When he began to realize, however, first of all, that the cell content was important in the life of the organism; secondly, that each cell might be said to be as it were, an independent and autonomous bearer of vital characteristics; thirdly, that each cell owes its vitality to its derivation from a previously existing cell so that there is genetic and developmental continuity between all of the cells of the body and the single cell from which the body is derived; and fourthly and finally, when he understood that the cell has not only structural but functional significance, when he gave us the basic thought out of which present-day anatomy with histology and embryology and microscopic neurology, pathology and even biochemistry, must necessarily take their origin for biology and medicine today would be unthinkable in any other terms than in terms of the cell theory. It must be admitted that Schwann had not as yet reached the definiteness of conception of the cell content which subsequent workers or contemporary workers in subsequent years achieved.

It is doubtful to me, for example, whether Schwann would have been prepared to give the name protoplasm to the content of the cell as Mohl did probably a few years after Schwann's announcement. Moreover, probably at no stage of his career, would Schwann have been ready to draw from the currents in protoplasm as discovered by Corti and subsequently rediscovered by Treviranus, the far-reaching conclusions which we today must draw. But after all, the suspicion is not unfounded if one tries to follow the writings of Schwann that the reason why he withheld naming the cell content was not because he failed to recognize its importance or because he was convinced as some authors claim he was, that the cell content is nothing else than some kind of "indeterminate slime" but because he may have had the suspicion that the cell content differs in different cells, foreshadowing again many of our viewpoints which rest upon the principle of the chemical differentiation of the cell content.

After all, modern biology was held back for more than two decades in its development in the '70s and '80s by the Darwinian popularizers, who saw too much significance altogether in the term "protoplasm" and who viewed it as the name of a chemical substance rather than as a convenient term for expressing certain collective characteristics of the content of all cells. It was only in the first decade of the present century that the work of the biochemists enabled us to recognize the true significance of the term protoplasm and had it not been for the development of colloidal chemistry, we should still probably, be in deep ignorance concerning the dynamics of protoplasm.

If I may seem to be ascribing here too much to the insight of Schwann, I shall gladly acknowledge that I am doing for him what the commentator on a literary masterpiece does with his favorite poem or drama. I am speculating not only on the meaning of Schwann's words but I am attempting to reconstruct the processes of his mind. It must be remembered that he had before him the writings of Bichat, who, as we have already pointed out, emphasized the differences in a particular tissue dependent upon the position of that tissue in an organ and its relationships to similar and dissimilar tissues in the same organ. In other words, Bichat recognized that we would today think of as tissue variability of cellular variability. We recognize the fact that cells and tissues just as organs and the organism may vary within sometimes, extremely wide limits and that the particular structure or function which exist at a particular moment, are the result of the intrinsic activity of the cell and of environmental influences even though in this case the concept of the environment must be extended to include the intra-organic environment. If Schwann had even the remotest idea of these present-day conceptions, his genius must have been even greater than that for which we have given him credit but this much is certain, that the thought would not have been far from his mind if one reads his papers conjointly with the basis of the tissue theory from which his thinking began.

Finally, it seems almost unnecessary to point out that deep concepts in genetics and in embryology, the concepts which we have formulated concerning development and growth, concerning cellular nutrition and cellular function, with reference both to cytoplasm and the nucleus, rest entirely upon Schwann's conceptions. At the time of Schwann's death in 1882, one great biological genius after another vied with all others in evaluating the greatness of his contribution to science.

From all over the world, particularly from the countries in which biological researches are being most actively prosecuted, came testimonials to the value of his work. In this year, we celebrate the hundredth anniversary of the publication of that contribution. Is it a coincidence that just at the beginning of this year, C. D. Darlington should publish his work on ''Recent Advances in Cytology''? In his foreword to this work, no less a person than Haldane points out ''that modern cytology has developed two outstanding features, namely, its principles are the same for plant and animal cells and the uniformity of nuclear mechanisms can be extrapolated with great confidence into the past so that the decision may be made that the principles of genetics and the method of evolution were much the same in remoter epochs as they are today.'' It is interesting that both of these features, that is, the universal applicability of the concept of cell structure throughout organic life and the continuity of the cellular processes, which Haldane regards as the essentials of the cell theory today, are already foreshadowed by Schwann himself, yet Haldane regards these, as all biologists must regard them, as the greatest achievements of modern cytology.

It is interesting that Darlington points out another feature which can scarcely be overlooked. He says that in cytology ''general principles have been discovered of such wide validity that we can predict from them with considerable confidence, and on the rare occasions when the prediction is philosophied, we are inclined to look for undetected causal agencies rather than to recast our first principles. This attitude has long been normal in chemistry and in physics. Its introduction into biology . . . is a sign of the growing unity of science'' (Isis, November, 1938,

p. 473). In other words, as Darlington hints, the deductive method is gaining validity as a method of scientific research because of the security of the human mind in accepting the conclusions in cytology which have been developed through the application of the inductive and the experimental methods.

And this brings us to just a brief word of comment on the fact that Schwann did ever so much more than simply to achieve the formulation of the cell theory. He was an anatomist and an embryologist and a physiologist of considerable note. He was also a biological philosopher and took part with considerable vigor in the arguments between vitalism and mechanism on the intellectual battlefields of his day. That he was a vitalist is, of course, accepted. He committed himself to a creationist's viewpoint of the world without any hesitancy but he saw with a clearness of insight that is characteristic of many a biologist who is not afraid to declare his faith, that the Creator works through secondary causes and that in the absence of other evidence, we must not invoke a direct divine influence in the universe if a particular result can be achieved through secondary causes traceable to be sure, in the last analysis, to an act of Omnipotence. The vitalism, therefore, which he defended was not a vitalism which stopped at a facile enunciation that an organism simply acts according to his nature as so many of the popularizers after him have done. His mind would not rest until he had penetrated deeply into the natural explanations of things based upon the ascertained and accepted laws as they manifested themselves in physical and chemical phenomena.

IV.

And now, may I devote my concluding remarks to the man himself? His father was a bookseller. From his earliest years, he was familiar with the domestic conversations concerning authors and their writings. We might even go farther and surmize that perhaps many an hour of his childhood days was spent among the shelves and volumes of his father's store. He was something of a dreamer but not a dreamer who is content with dreaming but a dreamer whose dreams became the actions in a world of reality. We might trace his breadth of interest, the comprehensive sweep of his scientific imagination and his quick and almost precipitate response to mental suggestions to the surroundings of his childhood days. His parents' family was large since he had numerous brothers and sisters, a blessing in the days when the ideals of German life in the comfortable cities and among the middle classes were productive of so much greatness.

He never married but he must have had an unique capacity for friendship. At the time of his death, it was pointed out that ever so many throughout the world mourned in him the passing of an intimate friend. Rarely in his letters, do we miss a personal note and the friendship which existed between Johannes Muller and Schwann and between Schleiden and Schwann are of themselves evidences of that capacity. To Muller, he was bound by ties not only scientific but also religious. The two men had much in common. Their fundamental viewpoints, their approaches to scientific problems, their interests were all closely related but it is amazing that a close friendship should have existed between Schwann and Schleiden, whose characters might be said to be as contrasting as any that could be thought of. Schleiden was impetuous, restive, imaginative, revolutionary, over-sensitive, unadaptable; Schwann was all that was contrary to these traits. Schwann could never even have contemplated suicide as his friend Schleiden did, even though his attempt was unsuccessful.

Their fundamental outlooks on life were poles apart, yet Schwann always felt a closeness of interest and the generosity of his nature in perhaps nowhere better shown than in his own epoch-making paper in which he gives the fullest credit to the insight of Schleiden and attempts even to read into Schleiden's views, interpretations which some critics might well regard as over generous. In fact, I suspect, that the reason why today we designate the cell theory as the Schwann-Schleiden theory is because of the emphasis which Schwann has placed in his papers upon Schleiden's contributions. If Schleiden were the more brilliant of the two in the boldness of his conceptions, Schwann was the more secure and objective scientist. In fact, as I think of the trilogy, Schleiden, Schwann, and Muller, and attempt to evaluate the attitudes which must have existed in Schwann's mind in attributing so much to Schleiden and of Muller's attitude in attributing so much to his pupil Schwann, I cannot but contrast this generosity with so much that is less desirable in some of the scientific controversies of today and yesterday.

As he grew older, the features of the developing man betrayed his character. A high forehead, the broad bridge of his nose, the gentle but flashing light of his eyes, the mild curve of his lip, the roundness of his chin, the character lines that played around his nose and mouth, all produced the impression of high dignity, noble purpose, unselfishness coupled with meekness, gentleness, kindliness, perhaps even with just a suggestion of weakness.

His critics have pointed out that after his large contribution, he had no other to make. During the nine years of his professorship at the University of Louvain and the thirty years professorship at Liege, so it is said, he produced no other creative work and there are not wanting, whisperings among the historians that as soon as he left Berlin to go to a Catholic University, the fire of his creative activity died. Some ascribe this to the absence of his guide and inspirer, Johannes Muller; others, to the depressing effect of a Catholic seat of higher learning; still others, to his voluntary estrangement from his mother country; still others, see in his silence, the expression of academic loneliness which in another form manifested itself in the isolation of his life; and still others have suggested that his natural character was content with but one achievement, intimating as they do, that after all, he was probably not fully aware of the greatness of his own contribution. Be the explanation whatever it may, Schwann led a happy life, a life full of joy of accomplishment, a life of contentment. He found comfort among the traditions of Louvain; he found satisfaction in the teachings and the practices of his faith; he kept his human interests alive by a personal contact and correspondence; he did not degenerate into a selfish prig nor into a self-seeking hermit nor into a social isolationist.

He moved among human beings and among his university colleagues and among his student body and his personal friends, as the kindly man to whom all things human were matters of personal concern. It is true he did not have at Liege and at Louvain, the facilities which he had left at Berlin; as a matter of fact, there seems evidence that it took several years before he again enjoyed the comfort and convenience of his own personal laboratory. But it would be unjust to say that his life was empty, that it failed of achievement, that it lost its significance as soon as he had made his significant contribution at the early age of twenty-nine years. Some historians are fond of pointing out that at the end of his life, he found himself somewhat in conflict with his Church. He was called in, as a matter of fact, as a member of a committee to examine a well-known stigmatise, Louise Lateau, of his day, and for a time, he sprang into a measure of prominence. He was asked to pass upon the miraculous character of the stigmata. In a well-reasoned opinion, he inclines to the conclusion that the phenomena which he investigated are not miraculous. Virchow makes much of this since Virchow himself was a member of the same commission and he praises Schwann for his scientific attitude but other writers, see in Schwann's opinion, a break with the traditions claiming, as Robinson does, for example, that the Church regards all stigmatization as miraculous. As a matter of fact, the attitude adopted by Schwann is precisely the attitude which the Church has always taken, that events are not to be accepted as miraculous unless the evidence for their supernatural character in incontravertible. There is no reason to assume that Schwann at any point in his life departed from the spirit of true science or from the spirit of true faith or that he found any difficulty in his synthesis of the two which he necessarily had to achieve in his own life.

And so, I offer this great man as an example of a great scientist by reason of his love of the truth and his ability to see in his observations, the meanings of nature. I offer him to you as the example of a learned Catholic whose intellectual convictions regarding the faith were never found to be inconsistent with his convictions regarding nature and as one who found in Catholic living the deepest satisfaction in his life, of self-devotion to his duty as a teacher. And finally, to this audience, I present him as a student of Loyola's, who has learnt to make the real objectives of life, the inspiration of his every thought and action, as one who has carried out the motto of Ignatius ad majorem Dei gloriam.

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EDITORIALS

The University of Washington

OUT of the Northwest comes our latest contribution to the series of campus editions of the Biologist. For its preparation and organization we are indebted to the Vice-Chancellor of Phi Sigma, Dr. Hatch. In laying out his material as a connected story, instead of a series of articles, we cannot but feel that Dr. Hatch has given us something a bit new and refreshingly different. As one reads the narrative of its gradual growth from the most unprepossessing of beginnings, one realizes just why the University of Washington has risen to its present commanding position in the Northwest. With the out-pouring of personal interest and self-sacrifice that came from the pioneering founders it could hardly fail to be otherwise. That the same spirit still flourishes among their descendants is more than evident.

"To Be, or Not to Be:"

THE threadbare lines from Hamlet's soliloquy have pointed more morals than any other lines outside of Scripture. Perhaps there is a good reason for it. It is a poor business that does not get a periodic inventory. The business of human living also needs its regular assessment, overhauling, and reorganization. So does almost every other type of human endeavor, whether it be social, economic, educational, scientific, or otherwise. In no particular branch of teaching is there so much need for periodic checkups as in the field of biology. All too easily, the professor, the instructor, the student, fall into the stereotyped attitudes more typical of the mathematicians, the physicist or even the chemist. Yet the very subject they deal with is that many sided, variable, unpredictable thing called "Life." To be, or not to be a biology teacher is a challenge to all the basic knowledge, the mental ingenuity and the personality at one's resource. It was Samuel Butler who pithily remarked: "'To be, or not to be', that is a question for an embryo, not for a man!" Perhaps it holds true in the preparation of biology teachers just as well. There are too many static teachers of a still more static biology who are on relief rolls today. Someone should have taken them in hand in their college days and firmly led them into another life-pursuit. There is an awesome lot of truth in the saying that,—"Biologists, like poets, are born, not made".

BOOK REVIEWS

The thumbnail sketches of current biological literature appearing in this section are not meant to be exhaustive or deeply critical. They aim to survey the rapidly growing field of biology. Naturally these reviews represent the candid opinions of various readers not necessarily those of members of the National Council, nor even those of the Editor.

ALICE IN VIRUSLAND, Paul F. Clark, *Society of American Bacteriologists, Madison, Wis., 1938.*

So few biologists have really played around with the humorous possibilities of their science, and all its resonant terminology, that it is a pleasure to discover this amusing bit of bacteriological persiflage. Dr. Clark has aptly fitted his dialogue to the characteristics of his anthropomorphized forms. The result is a delicious bit of fantasy well worth presenting to your bacteriologist friends.

THE AMERICAN SPECIES OF CREPIS, E. B. Babcock and C. L. Stebbins, Jr., *Carnegie Institution of Washington, Washington, 1938. Paper $2.00, cloth $3.00.*

This very complete and scholarly study of the indigenous species of Crepis, the Hawk's Beard, covers not only the taxonomy and the ecology of the forms, but throws not inconsiderable light on their distribution and interrelationships from cytological evidence of polyploidy and apomixis. As as intense correlation of genetic, morphological, and ecological studies it leaves little to be desired. Plant taxonomy is a fertile field for continued cytological and genetic research, but its possibilities are not making much headway, due principally to the lack of such exhaustive and pacesetting studies as this.

AN ANALYSIS OF COSTAL ALGONQUIAN CULTURE, Regina Flannery. *The Catholic University of America Press, Washington, D.C., 1939. $2.25.*

Anthropologists interested in the culture of those eastern American Indian tribes included in the Algonquian area will find in this rather exhaustive treatment of the subject a mine of information. The material is all the more helpful since the author has prepared this 219 page treatise not in advocacy of any particular theory, nor in championship of any particular anthropological interpretations. It has been presented as "a sounding to test the validity of the" analytical method. As such its findings have additional objective weight.

ANIMAL ECOLOGY, A. S. Pearse, *The McGraw-Hill Book Co., New York, 1939. $5.50.*

It is a far cry, not in time, but in quantity and quality, from the first to the second editions of Dr. Pearse's Ecology. From the slim little textbook first issued in 1926 to the rather impressive tome now before us, much water has gone under the ecological bridges, and a new textbook became just as desirable as the original first edition was necessary. Dr. Pearse has brought his work up to date, has reorganized all his material more logically, and has in so many ways improved its presentation that we feel safe in predicting for it even wider popularity than that which was won by its predecessor.

THE APE IN ANTIQUITY, William Coffman McDermott, *Johns Hopkins Press, Baltimore, 1938. $5.00.*

Anthropologists and historians of biology will be interested in this scholarly contribution to the Johns Hopkins University Studies in Archaeology. The average student of mammalian biology could well reenforce his general knowledge by a little helpful historical background such as that so profusely supplied by this volume. It is just a bit astonishing for the biologist to discover what a tremendous amount of literature and artistic remains we have referring to or portraying the various members of the primate groups.

APPLIED MYCOLOGY AND BACTERIOLOGY, L. D. GALLOWAY AND R. BURGESS. *Chemical Publishing Co., New York, 1938. $4.00.*

Although there has been a large number of bacteriological texts and a large amount of literature appearing for several years as the field has developed, this little 186 page work finds a long neglected place to fill. As a manual for applied bacteriology outside the specifically medical field, it opens with a first section devoted to general information regarding the fungi and bacteria, their nature, life-histories, culture, isolation and examination. The second half of the book is devoted to the more practical application of the knowledge thus presented, in the food, fermentation, textile and agricultural industries. The book should be a valuable reference.

BACTERIA, THE SMALLEST OF LIVING ORGANISMS, DR. FERDINAND COHN, *Translated by C. S. Dolley, The Johns Hopkins Press. Baltimore, 1939. $1.00.*

The excellent series of republications of epoch-making biological papers which has been appearing from the Johns Hopkins Press, adds another outstanding work to our library shelves. It was a happy thought for the press to choose an almost forgotten early American translation, thus immortalizing not only the original Cohn paper, but also its first American popularizer, Charles S. Dolley. Those who recognize Ferdinand Cohn as the forerunner and foreshadower of the great Koch, and the dawn of the golden age of bacteriology, will want to have this reprint in their files.

BICKNELL'S THRUSH, GEORGE J. WALLACE. *Boston Society of Natural History, Boston, 1939.*

This exhaustive study of a single group of the Hylocichla, the Northern and Newfoundland Gray Cheeked Thrushes, and Bicknell's Thrush more particularly, is so full of interesting details that it should be of value and help to many more than purely professional ornithologists. It is a very complete piece of research, competently done.

BIOLOGY FOR PHARMACEUTICAL STUDENTS AND OTHERS, S. MANGHAM AND A. R. HOCKLEY, *William Wood and Company, Baltimore, 1938. $6.50.*

Here is something new in the line of biological textbooks, at least to the average American biology instructor or student. The first three-fifths of the work are devoted to plants, the latter two-fifths to animals, but a large share of the introductory chapters treats of physiological functions which both possess in common. As a textbook for biology classes in the United States we rather suspect that it would not be popular, at least for freshmen classes. In the United Kingdom they do things differently. There the student who finished a course based on this textbook would really know some biology, and would have it pretty thoroughly organized. For our biology classes this book would be much too difficult, although a handy and profitable reference.

THE CHEMICAL FORMULARY, H. BENNETT. *The Chemical Publishing Co., New York, 1939. $6.00.*

The fourth volume in the series of chemical formularies issued by the Chemical Publishing Company of New York brings with it a lot of new material for synthetic experimentation in our chemical laboratories. For the biologist this might not appear to be, at first sight, a very practical manual. Closer inspection, however, proves to the contrary that there are several sections explicitly treating with biological formulae, notably those dealing with farm and garden specialties, food products, and textiles and fibres. The miscellaneous chapter will prove specially helpful with its mounting media, and formulae for defleshing skeletons, cheap Giemsa stains, freezing mixtures and the like. We rather suspect that all four of the annual volumes in this series will prove a profitable investment for the biological library.

COMMON EDIBLE AND POISONOUS MUSHROOMS OF SOUTHEASTERN MICHIGAN, Alexander H. Smith, *Cranbrook Institute of Science, Bloomfield Hills, Michigan, 1938. Paper $0.50, cloth $1.00.*

This, the fourteenth bulletin of the Cranbrook Institute, is a handy and clear little manual with any number of diagnostic characteristics for the safeguarding of those who like their mushrooms and are a bit fearful of doing their own collecting. There are sixteen excellent full-page plates, and an adequate glossary. The manual should prove helpful to all who are looking for a not-too-technical reference in field mycology.

CONQUESTS OF SCIENCE, Ray Compton and Charles H. Nettels, *Harcourt Brace & Co., New York, 1939. $1.20.*

If you were to take whole chapters from the most thrilling books of men like Beebe, Jordan, Muir, Sears, de Kruif, Andrews, Ditmars, and fourteen others equally as good, and were to offer them to a somewhat science-minded young American, it's a safe bet that you would have made a friend, not only for yourself, but also for Science. That is exactly what the Editors of this timely book have done. It deserves wide publicity, and patronage. It should be in every grade-school and high-school and public library. It would be a "grand" book to give as a prize, or as a birthday present. When you stop to think that every author is an acknowledged authority in his field, and these lengthy excerpts are from their best works,—well,—you wonder how it could sell as reasonably as it does.

ELEMENTARY ANATOMY AND PHYSIOLOGY, James Whillis, *Lea & Febiger, Philadelphia, 1939. $3.50.*

This is a compact, somewhat topical, clearly outlined, diagrammatically illustrated, 342 page manual for the use of students in general anatomy and physiology. Because no one in this country has done this kind of a job so excellently, it is to be hoped that this text will find many users in high school, or at least, college courses in general hygiene. As a textbook for nursing education it is simply invaluable.

FEATHERS AND FUR ON THE TURNPIKE, James R. Simmons, *The Christopher Publishing House, Boston, 1938. $1.75.*

This book serves a double purpose. The first part of it deals with bird and animal casualties on our highways, the second with the newer trends in conservation. Since it is written in a pleasant, narrative sort of style, it makes easy reading. Meanwhile the purpose of the author, who is an authority on his subject, is most efficiently carried out. Ecologists, and more especially, conservationists, will be glad to pick up new approaches to their special fields. The automobile-owning general reader will be awakened to a new interest in the wild life he sees along the highways.

FUNDAMENTAL PRINCIPLES OF BACTERIOLOGY, A. J. Salle, *McGraw-Hill Book Company, New York, 1939. $4.00.*

Here is a new bacteriology which has much to commend it. Designed for beginners in the subject, as well as to stimulate them to specilization in it, the text is unusual for what it includes, not what it omits. The student is gradually lead to the more complicated processes by a series of studies on basic laboratory practices and techniques. Then follow detailed treatments of water, milk and milk products, soil, air, foods, plants. The book concludes with chapters on specific infections, a history of bacteriology, and the preparation of solutions stains and culture media. Casual observation would lead your reviewer to believe that this is just the sort of manual many a teacher of bacteriology is looking for,—one which approaches the subject from a general viewpoint, rather than from the more intensely specialized viewpoint of the premedical course.

THE GARDNER'S TRAVEL BOOK, Edward I. Farrington, *Hale Cushman & Flint, Boston, 1938. $2.50.*

Biologists, whether they be botanists or not, are addicted to the gentle art of gardening. Once inoculated with the ambition to beautify their home premises they become interested in every type of gardening, whether it be vegetable or flower, natural or formal.

The next step is the arousing of interest in others' efforts at this absorbing hobby. Soon this interest steps over the boundaries of streets, city, and state until your gardening addict wants to see gardens wherever he travels. For such as these the Massachusetts Horticultural Society has had Mr. Farrington prepare this profusely illustrated and interesting volume. It covers every state in the Union, and parts of Canada. As a guide book to interested travel it will be invaluable.

ILLEGITIMATE BIRTH AMONG THE GUANANTUNA, JOSEPH MEIER, *Catholic Anthropological Conference, Washington, D.C., 1938. $1.00.*

Anthropologists and ethnologists will want this paper by a missionary who has painstakingly compiled the data he presents so inimitably. The locale of these observations is the northeastern corner of the Gazelle Peninsula, New Britain, Bismarck Archipelago.

LIFE'S BEGINNING ON EARTH, R. BEUTNER, *The Williams & Wilkins Co., Baltimore, 1938. $3.00.*

Dr. Beutner has long been known as one of our scientists most interested in the origin of life on our earth. His repeated articles and books have dealt with the same subject. In this newest work he brings the story of the preparation for life on this planet up to date in the light of Stanley's discovery of self-regenerating enzymes. There are four main divisions in the author's approach to the evolution of life on earth,—vital growth and crystallization; life, carbon's outstanding property; the importance of salt and water for life; the animal a machine.

MANUAL FOR COLLEGE BIOLOGY, GEORGE W. HUNTER, III, *American Book Co., New York, 1938.*

Designed to accompany Hunter, Walter and Hunter's *Biology*, which appeared last year, this laboratory manual offers much in the way of adapting many of the newer teaching techniques to college laboratory courses. Not a few new ideas are incorporated and most of them seem eminently practical. It might not be altogether practical to take a beginning biology class on a field trip, if the school were in a large city, but most suburban or rural colleges would do well to adopt the practice. After all, the science of life is just as much a field as a laboratory science. Too many biology classes never get a chance to realize this fact. There is still too much of what William Morton Wheeler called "the dry-rot of academic biology" in our teaching procedure. This laboratory manual should help to overcome some of it.

MEDICINE IN MODERN SOCIETY, DAVID RIESMAN, *Princeton University Press, Princeton, 1938. $2.50.*

A well-known member of the medical profession here presents a study of the history of medicine and some of the philosophical and social problems on which it throws light. The book deserves wide reading, deserves all the popularity that has come to it. It will help to open the eyes of people in general, and not a few of the medical profession, in particular, to the newer problems that are confronting one of the greatest and noblest professions in which men have engaged.

PHYSIOLOGY OF MUSCULAR ACTIVITY, EDWARD C. SCHNEIDER, *W. B. Saunders Company, Philadelphia, 1939. $3.00.*

This is the second edition of Dr. Schneider's very practical book for courses in physical education. Biologists and medical men who have anything to do with those who participate in strenuous athletic exercise should be familiar with all this book has to offer, whether they take it as a preparatory course or as a reference work.

PLANT CHEMICULTURE, C. D. DAWSON AND M. V. DORN, *Published by the Authors, 4615 West Washington Blvd., Los Angeles, 1939. $1.00.*

This is the third edition of a work previously reviewed in this magazine. The manual has been enlarged somewhat by the addition of new and some hitherto unpublished formulae.

PLANT PHYSIOLOGY, EDWIN C. MILLER, *McGraw-Hill Book Company, New York, 1938. $7.50.*

Of all the recent new editions which have come from the presses, this 1201 page work qualifies most easily for the description "impressive tome". It is about the largest handful of up-to-the-minute information on plant physiology on the textbook market today. As a text, or as a reference work, it should win many new friends.

POISONOUS PLANTS OF THE UNITED STATES, WALTER CONRAD MUENSCHER. *The Macmillan Co., New York, 1939. $3.50.*

This latest addition to the Rural Science Series will probably prove to be one of the most valuable of all. The last well-known work on poisonous plants appeared back in 1911. We have long needed such a reference work as this. That Walter Muenscher, whose "*Weeds*" was so favorably received not so long ago, was selected to prepare this volume, is an additional commendation. The library, botanical or otherwise, that lacks this volume is poor indeed.

PRINCIPLES OF GENETICS, EDMUND W. SINNOTT AND L. C. DUNN. *McGraw-Hill Book Co., New York, 1939. $3.50.*

In the melee of rapidly accumulating research results which have been piling up no where more rapidly than in genetics, it was inevitable that the well and favorably known Sinnott and Dunn textbook should come in for further revision. That this has been capably done goes without saying. That this has been done with no great increase in textual format, is altogether surprising and commendable. So many revisions seem to indicate an utter loss of the discriminatory ability to eliminate comparatively unessential details.

PRINCIPLES OF PALEOBOTANY, WILLIAM C. DARRAH, *Chronica Botanica Co., Leiden, & G. E. Stechert & Co., New Work, 1939. 7 guilders or about $4.00.*

We have long needed a new paleobotany which would gather up all the confusing threads of accumulating research, order them somewhat, and present the results in a clear and forthright fashion. This is what has happened in Darrah's new book. It will fill a long vacant place on our library shelves. This review would be wanting if it overlooked the fine work the Chronica Botanica Company is doing in the format it is giving to its publications. They are a joy to read, to hold, to own. American printers have much to learn.

SCHAFER'S ESSENTIALS OF HISTOLOGY, H. M. CARLETON, *Lea & Febiger, Philadelphia, 1938. $5.00.*

This is the fourteenth edition of the well known histological text which first appeared nearly fifty years ago from the hands of E. Sharpey-Schafer. The material is still organized in the familiar fifty lessons of the original. Many new photographs have been substituted for older ones or drawings. There is a profusion of colored illustrations, and the whole content has been thoroughly revised. The laboratory work is printed in smaller type at the head of each chapter, and there is a fairly extensive appendix of laboratory methods and techniques.

SCIENCE IN A TAVERN, CHARLES S. SLICHTER. *The University of Wisconsin Press. Madison. 1938. $3.00.*

To those many graduate students who in past years came under the watchful eye of Dean Slichter at the University of Wisconsin, the publication of this book will be met with mingled feelings. To some of them he was a bearish ogre guarding the approach to advanced degrees with a growling severity that was awe inspiring. To those who knew him better, for the genial student of men and things, transparently honest and outspoken, with a fund of classical knowledge, humor and literary ability unsuspected in the outstanding mathematician that he was. To none of this latter group will the publication of these essays be a surprise. They will welcome them, and the opportunity to secure them, as a last and worthy memorial of the really great character under whom they had the privilege of pursuing their graduate work. The very title of the book, based as it is on historic facts regarding the founding of many a scientific society, is redolent of Dean Slichter's unsuspected humor.

SON OF OLD MAN HAT, WALTER DYK. *Harcourt Brace and Company, New York. 1938. $3.50.*

This is the autobiography of an aged Navaho, as it was told to Dr. Dyk. Its ingenuous frankness makes it a most unusual type of anthropological case record. Aside from its scientific value, it is an interesting story, well told.

THE STUFF WE'RE MADE OF, W. O. KERMACK AND P. EGGLETON, *Longmans Green & Co., New York, 1938. $3.20.*

There have been all sorts of popularizing works written in almost every field of biology. It might be possible on a dare to practically make up a library of biological learning composed entirely of popularly written works. So far, however, the biochemical field has held out on the popularizers. Now, with the publication of this British work, that barricade too has broken down. The book seems worth while. It is not written "down" to the layman. It gives him credit for some intelligence and a little litteracy. For this reason the work should be justly popular.

TROUT STREAMS, PAUL R. NEEDHAM, *Comstock Publishing Co., Ithaca, N.Y., 1938. $3.00.*

Fishermen, and all lovers of outdoor sports, will be glad to know that so authoritative a book by so competent a writer has at last appeared. The problem of restocking and maintaining our trout streams is engaging more and more of the attention of those who are interested in the vital necessity of preserving our natural recreational resources. This handbook deals with the various members of the trout family, physical and chemical stream conditions, other animal inhabitants of trout streams, selection and distribution of trout foods, the propagation and protection of trout, and stream and lake management. It is safe to predict that this volume will soon find its way to the shelves of every conservationist.

WEATHER, GAYLE PICKWELL, *McGraw-Hill Book Company, New York, 1938. $3.00.*

The oft-quoted saying that "Everyone talks about the weather but no one does anything about it", is here given the lie in the grand manner. This 180-page volume with its broad pages filled with beautiful illustrations, with its chapter on learning the weather, and another on what man does about the weather, its liberal education on the reading of government weather maps, and its tell-tale pictures of erosion-effects, certainly are "doing something about it." There have been other weather books,—for meteorologists. Here is one for the average intelligent reader. It is worth buying, to keep or to give away. In either case, the recipent will be delighted.

WILD COUNTRY, F. FRASER DARLING, *Cambridge at the University Press, The Macmillan Co., New York, 1938. $2.75.*

F. Fraser Darling is an ecologist with more than the average ability with a camera. This book with its eighty-two excellent photographs of Scottish islands and their plant and animal inhabitants, will be interesting, not only to field biologists, but also to lovers of camera craft. For these the author has appended a page of directions and discriptions of the methods used in obtaining the uniformly excellent results shown.

THE WORLD WAS MY GARDEN, DAVID FAIRCHILD, *Charles Scribner's Sons, New York, 1938. $3.75.*

This is the autobiography of one of the greatest men in the field of foreign plant introduction who ever served his fellow men in the United States. The story reads like a novel, and is valuable for much more than the historical and scientific information it contains. This book should be on the shelves not only of every college, but also every high school and public library in the country. We are in need of more like it, to serve as incentives to young America to become science-minded, and we can hardly conceive of a type of book more likely to accomplish this laudable purpose than this thrilling life-history, so simply and so engagingly written. Dr. Fairchild has been a real contributor, to all our pleasure in the number of hitherto unknown plant forms which he has brought to this country, naturalized in the most favorable conditions possible, and then taught us to like them. How extensive his benefactions have been is not realized, perhaps will not be appreciated until long after he is gone. This book is timely.

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